This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

NEDL TRANSFER
HN 6LN7 B

G 9986

Lawrence Scientific School.

ENGINEERING DEPARTMENT.

HARVARD COLLEGE
LIBRARY

RUDIMENTS

OF

ARCHITECTURE.

LONDON:

R. CLAY, PRINTER, BREAD-STREET-HILL.

RUDIMENTS

OF

ARCHITECTURE,

PRACTICAL AND THEORETICAL.

COMPRISING SECTIONS UPON

THE MATERIALS EMPLOYED IN BUILDING.
THE METHODS OF COMBINING THE PRINCIPAL MATERIALS.
THE FIVE ORDERS OF ARCHITECTURE WITH THEIR PARTS, PROFILES, AND PROPORTIONS.
A CURSORY VIEW OF ANCIENT ARCHITECTURE.
A DICTIONARY OF TECHNICAL TERMS USED BY ARCHITECTS AND ARTIFICERS.
A TABLE OF FOREIGN MEASURES OF LENGTH.

BY

JOSEPH GWILT,

FELLOW OF THE SOCIETY OF ANTIQUARIES OF LONDON

SECOND EDITION.

ILLUSTRATED WITH SEVENTEEN PLATES.

LONDON:

M. TAYLOR, 1, WELLINGTON STREET, STRAND,

(NEPHEW AND SUCCESSOR TO THE LATE J. M. TAYLOR,)

REMOVED FROM HIGH HOLBORN.

1839.

~~KG 648.6~~

HARVARD COLLEGE LIBRARY

KG 9986

✓

HA... UN... MAY 1.1 73

PRINTED BY C. ADLARD, BARTHOLOMEW CLOSE.

TO

THOMAS BRANDRAM, ESQUIRE,

OF LEE, IN THE COUNTY OF KENT,

NOT LESS A ZEALOUS PROMOTER OF CLASSICAL ARCHITECTURE,

AND OF THE REAL INTERESTS OF ITS PROFESSORS,

THAN A CRITICAL ADMIRER OF THE BEAUTIES OF THE ART,

THE FOLLOWING SHEETS

ARE INSCRIBED

AS A MEMORIAL OF GRATITUDE

FOR HIS REPEATED ACTS OF KINDNESS TOWARDS

THE AUTHOR.

PREFACE.

At a period when the spirit for building seems to have taken possession not only of the Government and the inhabitants of this vast metropolis, but to have extended itself even to the extremest provinces of the kingdom, it is scarcely requisite to introduce this book to the reader, in the ordinary method adopted amongst authors, by alluding to the utility of its publication, however customary it may be to head their performances with allegations of the public want that is to be gratified by their appearance. I cannot however avoid observing as a matter for surprise that in England the theoretical and practical rudiments of civil architecture have not hitherto been collected and arranged as a manual for the use of the student and amateur.

Every person of liberal ideas must feel that his education is incomplete without some knowledge

of architecture: considered both as an art and a science, it is indeed so closely connected with the study of antiquity that a general acquaintance with it may be said to be absolutely indispensable. That nicety however and balance of opposing conditions in theory and practice, which are the aim of the professional artist, that knowledge which springs from varied experience, till it almost grows into intuition, are needless to the amateur; and to the student these sheets are merely intended as an outline which his perseverance and extended reading and observation will afterwards fill up. As a science, architecture requires great and multifarious information on the part of its professor, which it would be impossible even to advert to in the compass of such a work as this, and as an art it requires genius of an exalted nature which it falls to the lot of but few to possess. Such men as Palladio, Sanmichele, Jones and Wren, are rarely recorded in the annals of art.

The entrance into every class of knowledge is generally tedious, obscure and repulsive, though once passed, the prospects beyond it are refreshing

and entertaining. My aim has therefore been to divest the entrance to this art as much as possible of its ruggedness and perplexity; for study will always recommend itself to young heads or beginners in a science with more success from the easiness and pleasure of the practice than from the utility and importance of the subject. By an attentive perusal of the Rudiments I am inclined to think that sufficient knowledge will be gained by the person who studies architecture as an amusement, to make himself intelligible to the artificer when choice or necessity may lead him to indulge his fancy in designing. And the plates of the orders which accompany the text, having been selected from the best and purest examples remaining, will at least have a tendency to confirm a good taste if it be already innate, no less than to correct one that may be at all corrupted by misdirection or accident.

It might seem invidious to notice the elementary works already in existence. To the profession their demerits are too well known to need discussion, if this were the proper place for it.

Even the well known work* of that luminary of Oxford, Dean Aldrich, originally written in Latin, will give its reader very little useful information on the subject; it is indeed scarce more than a cento from the works of Vitruvius, Palladio and Alberti, and consists of instructions altogether inapplicable to buildings in this country, unless temples to the gods, antient Roman, and modern Italian houses and palaces should ever be in requisition from the English architect.

Had Sir William Chambers lived to fulfil his intention of giving to the public a practical work, it is not likely that I should have thought it necessary to write, much less to publish, the following pages: as the matter however now stands, no hints for construction are exhibited by that author, and this work, though not carried to an extent

* Elementa Architecturæ Civilis ad Vitruvii veterumque disciplinam et recentiorum præsertim A. Palladii Exempla probatiora concinnata. Auctore Henrico Aldrich, S.T.P. Ædis Christi olim Decano, 8vo. Oxon. MDCCLXXXIX. Printed with a translation of it by the Rev. Philip Smith, LL.B. Fellow of New College.

correspondent with that celebrated architect's Treatise on the Decorative Part of Civil Architecture, in two Volumes, may I hope be considered an useful introduction, no less than a companion to that invaluable book.

J. G.

Abingdon Street, Westminster.

CONTENTS.

PAGE

Dedication v
Preface vii
Directions for the Plates xv
Plates of the Orders of Architecture xvi
Introduction 1

SECTION I.

Materials employed in Building.

Timber 9
Stone and Flints 24
Bricks and Tiles 31
Slates 40
Lime, Sand, Water, and Cement 44
Glass 53
The Metals 56

SECTION II.

Methods of Combining the Principal Materials.

In Foundations 67
In Stone Walls 70
In Brick Walls and Bond 73
In Flooring 79
In Roofs 84
In Arches of Equilibrium 93
In Piers 100

SECTION III.

PAGE

THE ORDERS.

PARTS OF AN ORDER 105
PROFILE OF AN ORDER 107
TUSCAN ORDER 109
DORIC ORDER 111
IONIC ORDER 113
CORINTHIAN ORDER 115
COMPOSITE ORDER 117
HEIGHT AND DIMINUTION OF COLUMNS AND THEIR ENTABLATURE 119
PILASTERS 121
PEDESTALS 123
INTERCOLUMNIATIONS, ETC. 124
ARCADES AND PIERS 127
BASEMENTS AND ATTICS 130
PEDIMENTS AND BALUSTRADES 132
GATES AND DOORS 134
PROPORTIONS OF ROOMS, ETC. 136
STAIRCASES 138
VAULTS, GROINS AND DOMES 140
ABUSES 142
DESIGN 144

SECTION IV.

CURSORY VIEW OF ANTIENT ARCHITECTURE 147

SECTION V.

DICTIONARY OF TECHNICAL TERMS USED BY ARCHITECTS AND ARTIFICERS, AND FOREIGN MEASURES OF LENGTH . . . 171

DIRECTIONS FOR THE PLATES.

Contents of the Plates, I.* *to* VI.*, *which illustrate the Details of Construction, at page* 104.

PLATE I.* Various Examples of Flooring.

II.*, III.*, IV.* Various Examples of the Constructions of Roofs.

V.* Of Scarfing, on the Constructions of Domes, and of Vaulting.

VI.* Construction of Arches and Piers. Truss for a Girder.

PLATES

OF THE

ORDERS OF ARCHITECTURE.

		PAGE
PLATE I.	Parts which compose an Order	105
II.	Example of the Tuscan Order, after Palladio . .	109
III.	Example of the Doric Order, from the Temple of Theseus, at Athens	111
IV.	Another Example of the Doric, after Palladio . .	112
V.	Example of the Ionic Order, from the Temple on the Ilissus, at Athens	113
VI.	Another Example of the Ionic, after Palladio . .	114
VII.	Example of the Corinthian Order, from Temple of Faustina, at Rome	115
VIII.	Example of the Composite Order, from the Arch of Titus, at Rome	117
IX.	Examples of Arcades and Piers	127
X.	Of Designing	144
XI.	Examples of Bases to Columns	177

INTRODUCTION.

THE writers on Architecture have usually treated of it in respect of what they have denominated its three chief properties or conditions, namely, Utility, Strength, and Beauty, or as Sir Henry Wotton has it, "Commoditie, Firmeness, and Delight." The first of these arises from a just arrangement of the several parts, which should be suitably divided to answer the uses of the building, and each part in its proper situation. The second depends on an appropriate adjustment of the materials employed in the work; and the last is the result of the symmetry and true proportion of the different subdivisions, and of their harmony with the work as a whole, no less than with each other: the end, as all allow, being to build well.

In these introductory remarks it is not proposed to question whether the above division be a proper mode of treating the subject; but to submit a brief consideration of two of the most important points which press on us in the study of architecture as a science. An inquiry into the Elements of Beauty in Architecture would be out of place in a treatise of this nature, we

shall therefore proceed to the points alluded to, namely, UTILITY and ECONOMY.

UTILITY is only obtained by attention to the following matters. 1st, That the materials be of good quality, and disposed in their several places to the best advantage. That they be also of sufficient scantlings and strength to bear and resist the weights and pressures to which they may be subjected. 2nd, That the foundations be well secured and on solid bearings, the leading supports of sufficient size and number; bearing perpendicularly, and so distributed that the superincumbent weights may be as equally as possible diffused over the area covered by the edifice; and herein the student will do well to remember the quaint saying of the Provost of Eton, that "the foundation requireth the exactest care; for if that happen to dance, it will marre all the mirth in the house." 3rd, That in addition to the above, it is necessary that the different parts should be firmly connected with each other in an horizontal direction, by means of the floors, beams, roof-plates, lintels, and the like. 4th, Utility requires that the building should stand on a healthy spot, and not be subject to the reproach which Vitruvius casts on the town of Mitylene, "That it was magnificently and elegantly designed, but imprudently placed." And here it may be proper to remark, that the principal floor should always be sufficiently elevated above the surrounding ground, in order that it may be free from damp, and that the external walls should not be in contact with the soil, but protected by walls independent

of them, with continued cavities or spaces all round, which are usually called air drains: by these means the moisture which the external walls would otherwise constantly absorb and carry upwards is prevented. The healthiness of a building is moreover greatly promoted, by arranging the different apartments in such a manner that a thorough ventilation of them may be at all times procured. The roof, too, should be so constructed and contrived as to protect the building as much as possible from the effects of the sun and rain. 5th, It is of the highest importance in respect of the healthiness of a building, that very great care be bestowed on its thorough drainage, by means of sewers and cesspools: these, says Sir Henry Wotton, "how base soever in use, yet, for the health of the inhabitants, are as considerable, and perhaps more than the rest." 6th, Utility requires that the greatest attention be paid to the number, the magnitude, the situation, and the relative distribution of the several apartments and details, so that they may be proportionate and suitable to the purposes for which the building is erected.

Economy results from a judicious choice of figure for the general plan and form of the building, and a due rejection of all needless and superfluous ornament: the latter is not less injurious to the reputation of the architect than to the pocket of the sumptuary, and should always be avoided. As an example of the superiority of some geometrical figures over others, let us take the square. Suppose one, for instance, whose

sides are forty feet in length. It is manifest that the walling required to enclose this figure will be one hundred and sixty feet in length, and the area enclosed will be equal to sixteen hundred square feet: whereas in a building, whose form on the plan is that of a parallelogram, the opposite sides whereof are sixty feet and twenty feet respectively; the same quantity of walling will be required to enclose it, as was necessary for the square, though its area will be equal to only twelve hundred feet, or one fourth less than that of a building requiring the same quantity of walling, but whose figure is that of a square. Thus the square is superior to the parallelogram, though inferior in capacity to the circle. Hence edifices in which the greatest symmetry exists, are invariably of the least cost. And hence also simplicity and regularity in the general plan and its parts, are always conducive to Economy.

It has been well said by Durand in his "Preçis des Leçons d'Architecture," that the talent of an architect may be estimated by the practical method in which he solves the two following problems:

1st, With a given sum to erect the most suitable building, as in the case of private dwellings.

2nd, Information being supplied as to the accommodation wanted in a given building, to erect it at the smallest expense, as in the case of public buildings.

On these bases a sure foundation is laid for beauty in architectural works, which with the aid of the essential parts of decoration, namely, the orders of architecture

and their accessories, will assist the architect in attaining his end.

Though quaint, the Aphorisms of Dr. Thomas Fuller, the excellent and learned prebendary of Salisbury in 1631, are so well worth the attention of the student, that they are subjoined:

"Let not," says the worthy Prebendary, "the common rooms be several, nor the several rooms be common," by which he means that the common rooms should not be private, nor the private rooms common. "The hall ought to lie open, and so ought galleries and stairs, provided the whole house be not spent in paths. Chambers and closets ought to be private and retired."

"Light (God's eldest daughter) is a principal beauty in a building. Yet it shines not alike from all parts of the heavens. An east window gives the infant beams of the sun before they are of strength to do any harm, and is offensive to none but a sluggard. A south window, in summer, is a chimney with a fire in it, and needs to be screened by a curtain. In a west window, in summer time, towards night, the sun grows low and over familiar, with more light than delight. A north window is best for butteries and cellars, where the beer will be sour, because the sun smiles upon it. Thorow lights are best for rooms of entertainment, and windows on one side for dormitories."

"As for receit, a house had better be too little for a day, than too great for a year: and 'tis easier borrowing of thy neighbour a brace of chambers for a night, than a bag of money for a twelvemonth. It is vanity,

therefore, to proportion the receit to an extraordinary occasion; as those, who, by overbuilding their houses, have delapidated their lands, and their estates have been pressed to death under the weight of their house."

"As for strength, country houses must be substantives, able to stand of themselves, not like city buildings, supported by their neighbours on each side. By strength I mean such as may resist weather and time, and not invasion, castles being out of date in England, only on the sea coast. As to making of motes round a house, 'tis a question whether the fogs that arise from the water be not more unhealthful than the fish brings profit or the water defence."

"Beauty. Let not the front look a-squint on a stranger, but accost him right at his entrance. Uniformity and proportion are pleasing to the eye, and 'tis observed that freestone, like a fair complexion, soonest waxeth old, whilst bricks keep their beauty longest."

"Let the offices keep their due distance from the mansion-house. Those are too familiar which presume to be of the same pile with it. The same may be said of stables and barns, without which, a house is like a city without works, it can never hold out long."

"Gardens also are to attend in their place. When God, Genesis ii. 9., planted a garden eastward, he made to grow out of the ground every tree pleasant to the sight and good for food. Sure he knew better what was proper to a garden, than those who now

a-days therein only feed the eyes, and starve both taste and smell."

For the purpose of communicating his ideas, the architect must have recourse to drawing, which is the language not less of the architect than of the painter: with this the student is supposed acquainted. In addition to the power of laying down on paper the plan, section, and elevation of a building, which presupposes the knowledge of common and descriptive geometry, and that of drawing with facility the human figure and every species of ornament, he should possess a thorough knowledge of the laws of perspective to enable him to make representations of a building from every point of view, so that he may judge of its effects in respect of the projecting and receding parts.

One of the most important subjects on which the architect should be informed, is a knowledge of the materials used in building. Sir Henry Wotton says, "THAT surely cannot disgrace an architect, which doth so well become a philosopher." First, then, will be submitted to the consideration of the reader, some account of the Materials used in Building. The second Section of this work will consist of a concise description of the method of combining the principal of those materials in Foundations, in Stone and Brick Walls, in Floors, Roofs, Arches, and Piers. The third Section will contain an account of the Five Orders and their parts, with general instructions on the proportions of Arcades, Basements, and other detail. In the fourth

Section will be comprised a Cursory View of Ancient Architecture. And in the fifth and last will be given a General Dictionary of the Technical Terms used by Architects and Artificers in the practice of Architecture as a science as well as an art.

SECTION I.

OF THE

MATERIALS EMPLOYED IN BUILDING.

TIMBER.

OAK. Of Oak there are no less than fourteen species, whereof, says Dr. Hunter, The QUERCUS ROBUR, or common English Oak for ship building and other economical purposes, far excels all the kinds in the known world. Miller considers that, of which, in the wolds of Kent and Sussex, there are many large trees, as a distinct species, and designates it under the title of QUERCUS FŒMINA, by some called the Pedunculated Oak. Of this the leaves are not so deeply sinuated as those of the common oak, nor are they so irregular, and it is moreover distinguished from the Quercus Robur by the circumstance of the acorns being on long fruit stalks, whilst those of the Robur are nearly sessile. Some prefer the latter to the former species, perhaps from the circumstance of its having, in growth, a more lofty appearance. The first named is that in which we are more immediately concerned. It is the pride and

glory of the forests of our island, succeeding in almost every soil, though it most delights in that which is rich, deep and loomy.

There is a species of oak that comes from Norway, called clapboard, and another which is called Dutch wainscot, imported from Holland, but grown in Germany, and floated down the Rhine to that country for exportation. The former is distinguishable from the latter by the light coloured streaks which cross it in various directions. The use of these woods has latterly diminished in this country. Wainscot is softer than the common oak, but it is not so liable to warp and split. In this respect, also, the clapboard is far inferior to wainscot.

Oak, when used in damp situations, decays gradually from the external surface to the centre of the tree, the outside ring or that which it acquired in the last year of its growth decaying first: but when the tree is not cut down till past its prime, the decay is reversed, by its commencement at the centre. That which has arrived at its full growth, which it rarely does under a hundred years, is best suited for the purposes of building, and it may be further observed that oak under its maturity is stronger than that which has passed it.

If the architect has the choice of his timber while standing, it should fall on the most healthy, vigorous and flourishing trees. Those whose trunks are most even should be preferred. If there be any swelling above the general surface of the wood, it is a mark of decay. A dead branch at the head is a suspicious

omen, but if the tree be otherwise desirable, let the root be examined; if that be sound, there may be reason to suppose that the dead branch is an accident; otherwise, the tree ought to be rejected. Alberti recommends all the oak used in the same building to be cut from the same forest, but this is perhaps a little too fanciful.

In felling, the large branches should be first cut off, so that in its fall the main timber of the tree may not be injured. The trunk moreover should be sawed as near the ground as possible. When the tree is cut down, and not before, it may be barked, trimmed of its branches and laid in water for some time to season.

It should however be squared with all convenient speed even before seasoning, which operation, according to the opinion of the workmen, prevents in a great degree its liability to split. Boring the timber when it is to be used for posts and columns, has been found effectual in preventing its splitting; but when it is wanted for beams, girders, and the like, this would be an absurd practice.

Though for knees and similar purposes a curvilinear direction of the fibres of the timber may be occasionally desirable; yet for other purposes, those pieces are to be chosen that have the straightest grain: connected with which condition we may generally take it as a rule, that of two pieces equally dry and of equal dimensions, the heavier is the better piece.

Banks found that the worst or weakest piece of dry oak one inch square, and one foot long, bore 660

pounds in the middle, though much bent by that weight: two pounds more broke it. The strongest piece which he tried of the same dimensions broke with 974 pounds*.

* To find the relative strength of two or more pieces of timber:

Multiply the square of the depth of each piece of timber by its thickness; the product of each being divided by its respective length, will give a quotient expressing its relative strength.

Thus to ascertain the relative strength of two pieces of oak, taking 660 as the measure of strength (see text), one of them eight feet long and six inches square, and the other six feet long, 6·364 inches deep, and four inches wide, we have

$$660 : \frac{1 \times 1 \times 1}{12} = 660 : \frac{1}{12}$$

Therefore $\left(\frac{6 \times 6 \times 6}{96} \text{ then}\right) \frac{1}{12} : 660 :: \left(\frac{6 \times 6 \times 6}{96} =\right) \frac{216}{96} :$ 17820 pounds.

And $\left(\frac{6{\cdot}364 \times 6{\cdot}364 \times 4}{72} \text{ then}\right) \frac{1}{12} : 660 :: \left(\frac{6{\cdot}364 \times 6{\cdot}364 \times 4}{72} =\right) \frac{162}{72} :$ 17820 pounds. So that these two pieces are equally strong and capable of bearing the same weights.

To find the depth of a piece of timber whose length and breadth are given, so that it shall bear a weight equal to or greater than another piece, whose length, breadth and depth are given:

Multiply the square of the depth of the last piece into its breadth, and divide the product by its length. The quotient thus obtained is to be multiplied by the number of times the first named piece is to carry more weight than the last (but if it is to be only equal in strength, one will of course be the multiplier), and that product by the length of the piece whose depth is to be found, and divide by its width. Extract the square root of this last quotient, and it will be the depth sought.

Thus let the piece whose depth is required be four inches wide and six feet long, the other piece being eight feet long, six inches wide, and six inches deep, to make them equally strong.

Then $\frac{6 \times 6 \times 6}{96} = 2{\cdot}25$ and $2{\cdot}25 \times 1 \times 72$ inches $= 162$

$162 \div 4 = 40{\cdot}5$ whose square root 6·364 inches is the depth sought.

. It is to be observed that in the oak as in all other trees, the wood of the boughs and branches is far weaker than the wood of the body of the tree; that of the great limbs stronger than that of the small limbs;

To find the breadth of a piece of timber whose length and depth are given, so that it shall bear a weight equal to or greater than another piece, whose length, breadth, and depth are given:

Square the depth of the piece given, and multiply that square by its width, divide this product by the length. Then multiply the quotient by the number of times you would have the piece stronger. As the square of the depth is to the last product, so is the length of the piece (whose width is sought) to the width.

Thus let the piece whose width is sought be six feet long and 6·364 inches deep, the other piece being eight feet long, six inches wide, and six inches deep, to make them equally strong.

Then $\frac{6 \times 6 \times 6}{96} = 2{\cdot}25$ and $2{\cdot}25 \times 1 = 2{\cdot}25$

As $(6{\cdot}364 \times 6{\cdot}364 =)$ 40·5 : 2·25 : : 72 : 4 inches, the width sought.

Buffon found that two-thirds the weight sufficient to break a beam, when first applied, weakened it very considerably, and sometimes even broke it at the end of two or three months. Half of this weight brought it to a certain curvature, which did not increase after the first minute or two, and which might have been borne by the beam for any length of time. One-third seemed to have no permanent effect on it, for it recovered its rectilineal shape after having been loaded for several months; that is to say, one-third of the weight, which would quickly break a seasoned beam, or one-quarter of what would break one just felled, may lie upon it for ever without giving it a *set*.

The subjoined table shewing the comparative strength of oak with other woods, is from Emerson, taking oak at 1.

Oak, Box, Yew, Plum-tree	1·000
Elm, Ash	0·772
Walnut, Thorn	0·681
Red Fir, Elder, Plane, Crab-tree . .	0·636
Beech, Cherry-tree, Hazel	0·606
Alder, Birch, White Fir, Willow· . .	0·545

and the wood in the heart of a sound tree stronger than all. Wood is weakest when green, and strongest when thoroughly dried, and should be at least two or three years old before it is used. If sappy it will not only be weaker, but decay sooner. Knots weaken it, and fractures most occur where they are situated. Cross-grained pieces must always be rejected.

Oak exceeds almost all other wood in strength, solidity and durability: it is also more universally serviceable; the crooked pieces, as we have before said, being useful for knees and braces, and the smaller fragments for rails, laths and pegs for tiling.

No wood is better calculated to bear and suspend weights, nor is there any which better endures the wear of alternately wet and dry situation. The roofs and joists of many of our ancient buildings prove it to be almost everlasting. It is excellent for door-cases, window frames, in plank for barn floors, and for stairs: in short, where durability and strength are desired, no other timber can come in competition with English Oak.

About thirty-nine cubic feet of oak weigh one ton.

FIR. There are twelve species of this timber. Of these, three sorts especially claim the architect's attention, from their being more commonly used for building purposes; though the wood of almost all the species is more or less employed. The first is the PINUS PICEA or Silver Fir tree. It grows very upright; branches not numerous; bark smooth and

delicate; the leaves grow singly on the branches with their ends slightly indented; their upper surface is of a strong green colour, the under side having an ornament of two white lines running along each side of the mid-rib: on account of their silvery appearance this tree has obtained the name of the Silver Fir. It is common in the mountainous parts of Scotland, in Norway, and on the shores of the Baltic, and affords the yellow sort of timber. From its yielding pitch it has also gained the name of the Picea or Pitch tree.

The second species is the PINUS ABIES or Spruce Fir, which produces the white sort of timber. It is a native of Norway and Denmark, where it grows spontaneously, and is one of the principal productions of the woods there. It is also plentiful in the Highlands of Scotland. There are several varieties of this fir which it is unnecessary to notice in this place.

The third species is the PINUS STROBUS, better known by the name of the American Pitch Pine; it is a white sort of wood, and grows to an amazing height.

The best sorts of fir that come to England, for comparatively little of our own growth is used, are those known to the workmen as coming from RIGA, MEMEL or DANTZIC. There is an inferior sort which is imported in smaller logs, called Dranton or Dram timber.

As in foreign fir we have not the opportunity of choosing our timber before it is felled, we must confine ourselves to the choice of the best sorts that are imported.*

* The purchase of fir timber is by the load of fifty cubic feet.

DEALS, which are the wood of the fir-tree cut up into thicknesses in the country whence they are imported, are had chiefly from Christiana, and other places in Norway, from Dantzic, St. Petersburg, &c. Their most usual thickness is three inches, and they are generally nine inches wide*. It is of the last importance that deals should be well seasoned, for no wood is more apt to shrink and fly. They should be so stacked as to allow a constant action of the air on their surfaces for a considerable time before they are used. White Fir and deal should be employed in inside works only, from their greater liability to shrink and fly than the yellow sort, which stands the weather much better.

There is no wood which so well agrees with glue as the fir, nor any which is more easily wrought; added to which, its lightness makes it very expedient in use where that quality is required. It is however easily compressed by any force acting at right angles to its fibres, and wherever compression of that kind is likely to arise, oak or one of the hard woods should be substituted for it. It will, notwithstanding, bear a weight in the direction of its fibres, better it is said than even oak itself. It is principally used for flooring, partitions, boarding of floors, doors, windows, mouldings, dadoes, the panelled framed linings of rooms

* Deals are purchased by the hundred, which contains one hundred and twenty deals reduced, be their actual thickness whatever it may, to a standard thickness of one inch and a half, and a length of twelve feet by means of calculation.

Whole deal is that which is one inch and a quarter thick, and slit deal is half that thickness.

which are improperly called wainscottings, chimney-pieces, &c.

Banks says, that the worst piece of deal which he tried, twelve inches long and one inch square, bore 460 pounds, but broke with a little more. Strength generally implies weight, and where the duration of oak is not wanted, fir may most properly be used.

A cubic foot of yellow fir weighs from thirty to thirty-seven pounds. The same quantity of white fir from twenty-five to thirty-three pounds.

CHESTNUT. The Chestnut, Castanea Sativa, not the horse-chestnut which is chiefly used for purposes of turnery, deserves to be ranked with timber-trees of the very first class; it is indigenous to this country, though the culture of it is now unfortunately too much neglected amongst us. It was formerly much cultivated in this island, and appears to have been the timber most applied to building purposes in early times. Independent of its very ornamental appearance when growing, it is as valuable as oak, and, in some respects, superior to it; and it is most desirable that the antient spirit of propagating it were revived in the present day. In colour, substance, and quality, it so much resembles oak, that it is with difficulty workmen distinguish one from the other; but this may be taken as a certain sign, that in oak, before dry, wherever a nail or bolt has been driven, a black substance will appear round the iron, which is never the case with chestnut. Water-pipes of this wood endure much longer than those of

elm; and for tubs and vessels to hold water it is superior to oak, for when once thoroughly seasoned, it is not subject either to shrink or swell; hence the Italians make their wine tuns and casks of this wood. The chestnut will thrive on most soils and in all situations; though it delights much in a rich loomy land, it will succeed very well on that which is gravelly, clayey or sandy; all mixed soils are suitable to it, even the declivities of hills and other exposed situations.

The weight of a cubic foot of chestnut is about forty pounds.

WALNUT, JUGLANS (quasi Jovis glans), is of several sorts. JUGLANS REGIA, the common walnut, was formerly much cultivated in this island, as well for the sake of its timber as of its fruit; but the importation of mahogany has long since rendered its cultivation on the former of these accounts much less common. It delights more in a thin lime-stone soil than in one rich and deep, and if raised for timber, should always remain in the place where it is sown. It is a beautiful wood, and now much too valuable to be appropriated to building purposes; it was, however, formerly used in roofs and floors, though in the present day it is only employed for cabinet-work, gun-stocks, &c. One of its properties is, that it is less liable to be affected by worms than any other timber, cedar only excepted, but from its brittle and cross-grained texture it is not generally useful for main timbers in building.

A cubic foot weighs about forty-five pounds.

MAHOGANY. MAHAGONI has only one known species, SWIETENIA. It is a native of the warmest parts of America, is found in the islands of Cuba, Jamaica, Hispaniola, and also in the Bahama Islands. It abounded formerly in the low lands of Jamaica, but it is found there in the present day only on high hills, and in places difficult of access. It thrives in most soils, varying in quality, according to their different natures. In rocky places, though of smaller size, it is harder, weightier, of a closer grain, and more beautifully variegated than in the low richer lands, whereon it is produced more porous, paler in colour, and of opener grain. It rises straight and tall, and when full grown, reaches to a diameter of four feet; its flowers are of a red or saffron colour, and the fruit about the size of a turkey's egg. This wood is extremely hard, takes a fine polish, and is admirably adapted to articles of furniture. It is here so esteemed and costly that it is rarely used in building for other purposes than doors, hand-rails of stairs, &c. In Jamaica it has frequently been used for floors, joists, rafters, shingles, &c., and ships have been built of it, for which purpose, the circumstance of its burying the shot without splintering renders it peculiarly fitted.

The first use to which it was applied in this country was by a Mr. Wollaston in making a candle-box for a Dr. Gibbons, at the beginning of the last century. The Doctor was so much pleased with its appearance that he afterwards had a bureau made of it.

The Jamaica mahogany is much harder and more durable than the Honduras or American, and may be easily distinguished from them before either is oiled, by the pores of the two latter appearing quite dark, while those of the former have a white appearance, and as if filled with chalk.

A cubic foot of Jamaica mahogany weighs about fifty-four pounds. A cubic foot of the Honduras rarely weighs more than thirty-eight pounds.

ASH. FRAXINUS EXCELSIOR, or Common Ash, is a very common tree, and grows in most parts of England. There are two other species which do not interest us, from the circumstance of their rarely growing to a large size. The common ash grows best in a light, rich mould, rises quickly, and its timber is very tough, strong, and durable, while protected from the weather, but if exposed to it soon falls to decay. For purposes of strength, when the other hard woods already described cannot be procured, it may be properly introduced. The outside rings of this tree are the toughest.

A cubic foot weighs from fifty to fifty-two pounds.

ELM. ULMUS CAMPESTRIS, or Common Elm, by some called the Wych Elm, and the ULMUS GLABRA, or Smooth-barked Elm, are the most valuable species in respect of their timber. The north-western counties of this island are said to produce those of the largest size. It thrives best on a loomy soil, and is of quick growth; the timber is strong and sound, but very cross-

grained, and therefore not proper for those roofs or floors in which there is any considerable strain or stress; it is also very liable to warp, and shrink breadthwise as well as lengthwise; it has, however, the property of bearing the drift of bolts and nails better than almost any other timber, from its not being apt to split. It was, till superseded by cast-iron, much used for water-pipes; is excellent for piles when constantly under water, but will not bear alternate dryness and moisture. For dressers, chopping-blocks, and other domestic purposes of that nature, it is admirably adapted.

A cubic foot weighs about thirty-six pounds.

BEECH, FAGUS SYLVATICA, is a beautiful tree; it grows to a considerable height, carrying a proportionable trunk; it flourishes most in a dry warm soil, and grows moderately quick. The wood is hard, close, and has a fine even grain, and, like elm, bears the drift of bolts. Constantly under water it may be used for piles, but it is exceedingly improper for beams, rafters, or other bearing timbers, as the smallest degree of dampness at the ends soon brings it into a state of decay. It may be well employed in the commoner sorts of furniture and fittings.

A cubic foot weighs about forty-three pounds.

POPLAR, POPULUS, is of several species, but the best sorts of it are the White Poplar, or Abele Tree, the Black Poplar, so called from a black circle perceived at its centre when felled, and the Trembling

Poplar or Aspen Tree. Poplars grow very freely in this country, and delight in damp soils: their timber, however, is little used, though it has many good qualities; it is light, but not strong; requires little seasoning, and shrinks but in a small degree, possessing a fine white colour and beautiful grain, and may be used in floors and stairs. This wood does not readily submit to the action of fire.

A cubic foot weighs from twenty-five to twenty-eight pounds.

SYCAMORE, ACER. This tree thrives well on a light moist earth, and is a quick grower; it is white and of beautiful grain, in that respect resembles the poplar, but is much stronger. Ware says there are old houses in this country floored with sycamore, and wainscotted with poplar. It is well calculated for floors, in which situation it will neither cast nor shrink.

A cubic foot weighs about thirty-seven pounds.

LIME, delights in rich loomy ground, is quick in its growth, white, and of an even grain. It is very liable to split. For carving it is preferable to deal and most other woods.

A cubic foot weighs about thirty-two pounds.

BIRCH. BETULA ALBA, or Common Birch, is a handsome tree, and there are few moist places in this kingdom in which it does not naturally grow. Of it there are five species: the Common Alder (BETULA

ALNUS), being one of them. Birch is equal in quality quite through the tree, is very tough, easily affected by the weather, and is, moreover, very liable to be attacked by worms.

A cubic foot weighs about forty-five pounds.

Besides the above trees, the service, quickbeam, hornbeam, maple, cherry-tree, pear-tree, &c., all possess qualities which might render their employment useful in parts of our edifices, and it is much to be regretted, that the use of foreign fir in this country is so general, that the encouragement for rearing timber for our own use seems to have long fallen off. Surely it is worth the attention of Government to take steps for fostering the growth of timber in this island.

STONE AND FLINTS.

EACH of these materials is too well known to require description. Of the former, there are in this country more varieties than provinces, amongst them lime-stone, or that which is generally burnt into lime, will be hereafter noticed.

Freestone, a term which has been used in a very arbitrary way, is that which its name implies, namely, stone which can be worked with the chisel and mallet, or cut with the saw, as the Bath stone, which is not the case with granite, whose hardness requires that it be dressed with pointed tools of different weights and sizes. It is sometimes also called sandstone; and is found in strata of very different dimensions and inclinations, varying from almost the thinness of a slate, to the thickness of those enormous blocks of Portland which are sometimes extracted from the quarries. Its component parts vary in quantity, being more or less calcareous, argillaceous, and siliceous. The Bath stone, however, is almost entirely calcareous, and will make lime-water without calcination. Though very soft when first removed from the quarry, and cut easily with a carpenter's common saw, it soon becomes hard and

durable by exposure to the action of the air*. In most quarries the under are harder and thicker than the upper beds: and it is well to observe, that in bedding courses of stone, they should stand in the same direction as the stone lay in the quarry.

Stone as it lies in the quarry, has what the workmen term a *cleaving* and a *breaking* grain; the former being in the direction of the beds of the laminæ, and the latter in a vertical direction. They draw the stones in the following manner. Having uncoped it, that is, taken the soil from it, they drive thereinto wedges, in the direction of the cleaving grain, till they loosen the block; then, marking on it the width they would have the block, a small channel is cut along the boundary of its width with the stone axe, in which channel, wedges six or eight inches asunder, are equably driven by gentle and repeated strokes, and if some of the wedges drive harder than others, these are driven so as to keep the whole going together. They then proceed to break it off in length in the same manner. In some cases gunpowder is used to blow up the masses of stone. In Portland and other harder stones, the cleaving grain is not so apparent as in others. A more particular description of that species, which from its use in London is particularly important, is therefore submitted.

The Isle of Portland has its upper surface pretty

* The qualities of Bath stone vary considerably: some of the quarries produce it so bad that the architect must be very circumspect in its use.

flat, and rises generally to a level of about two hundred feet above the sea. The strata of stone lie nearly parallel with the upper surface of the island, with but little depth of soil thereon. The MERCHANTABLE BEDS of stone are usually covered with a stratum called the CAP, harder than that which they cover, but not so sightly, being a congeries of various species of petrified sea shells, very distinct and separate in their forms. The CAP is generally blasted off with gunpowder. The large flats are then split with wedges, into large irregular blocks, and the quarry-man, with a tool called a KEVEL, which is a peck at one end, and a hammer at the other, SPAWLS off, by a repetition of blows, large shivers of the stone, bringing it, by the aid of his eye alone, to the largest cubic figure into which it can be reduced. These masses come from his hand in blocks, varying from half a ton to six and even eight tons weight. It is then removed by carriages of a suitable construction, down an inclined plane to the pier, in order to be shipped.

The Sandwich or Swanage quarries produce the flat Purbeck paving and steps. The strata of these seldom exceed twelve inches in depth: they lie under a considerable depth of soil, and are therefore chiefly worked under ground; the upper part of the quarries being supported by pillars built up of rough stone. In the neighbourhood of these are the quarries whence the stone denominated Purbeck Portland is extracted. Herein the merchantable beds lie very similarly to those at Portland, but having more soil on them, are in

some measure worked under ground. This stone is inferior in colour and harder to work than Portland, though very like it. It is calcareous, not of the grit kind, like Yorkshire.

The hard cross-grained stones are differently quarried, namely, by means of wide and deep channels cut on the surface, confining the wedges placed therein by iron bars, which are then driven down. Gunpowder is also used for separating the stone from its bed, but it blasts so irregularly, and causes so great a waste of stone, that the other mode generally pays best in the end*.

The Ryegate, a soft stone of Surrey, is capable of enduring the heat of even furnaces without injury, and is in common use for lining fire-places. It works

* Palladio advises that stone be wrought as soon as possible after its removal from the quarry, because it works easier. All stone, he says, hardens when exposed to the air: on this account, let no stone be despised because it is soft when lying in its bed. When found in a new place and its quality unknown, it should be tried by exposure to the air. Vitruvius recommends its being submitted to the action of the air for two winters, and that it be quarried in summer, so that it may be gradually brought to bear the winter's frost, from which, if suddenly subjected thereto, on removal from its natural bed, it might receive considerable injury.

Alberti, with much more reason than when he recommends all wood in a building to be from the same forest, advises that all stone used in the essential parts of a building, be from the same quarry; thus the work may be expected to endure more equally, all the points of support being of the same texture and density.

Generally those kinds of stone which work easiest, decay soonest, hence the necessity of choosing the hardest sorts for external works.

easily, but is totally unfit for any other purpose than that just named.

The principal quarry stones of England, beside those already named, are found in Dorsetshire; of these there are two sorts, one a whitish free-stone resembling the Bath stone, and another sort considerably harder. In Northamptonshire, a grayish species. In Yorkshire, a gray sort full of spangles; particularly the Bramley Fall. Yorkshire also produces excellent paving, known by the name of ELLAND EDGE. Derbyshire yields a good strong coarse stone. In Sussex, Oxfordshire, Gloucestershire, and Warwickshire, are also found species of good fair building stone. Until lately, the colour and hardness of Portland have, combined with the superior facility of its carriage, caused it to be the sort most generally used in the metropolis.

Portland stone is used for outside work, chimney-pieces, paving-steps, copings, shafts, bases, and capitals of columns, and carving generally.

The Purbeck stone is mostly confined in its use to paving and steps, for which, from its hardness, it is admirably adapted.

The Scotch stones from Cragleith and Dundee, lately introduced into the metropolis, are a valuable acquisition to the builder. The former, in appearance as well as strength, is quite equal to Portland, the latter is equally good, except as to colour, which has perhaps prevented its employment in ornamental works, but without sufficient reason.

For durable work no sort of stone is equal to granite. In the southern part of this island, Cornwall excepted, it does not abound; but in Scotland there is not only an abundance of it, but many varieties of different colour and quality.

The gray granite or moor-stone, as it is called in Cornwall, is got out into blocks by splitting it with a number of wedges applied to notches *pooled* in the surface of the stone about four inches apart. The *pool-holes* are sunk with the point of a *peck*, much in the same way as other hard quarry-stones are split. The harder the moor-stone the more exactly it can be split to the scantling required. Granite may be wrought into mouldings by means of pointed tools of various weights and sizes, but it is first roughed out by means of heavy hammers, whose shape is formed by two acute-angled triangles, joined base to base by a rectangle between them thus .

Red granite is harder than the gray sort, and more difficult to work. The Peterhead, from the vicinity of Aberdeen, is perhaps the best; it is at least the most beautiful in appearance, which Scotland produces. It takes a beautiful polish, and, being a rich material in respect of colour, may be well applied in chimney-pieces, columns, tables, &c. This, in point of beauty, is surpassed by the oriental granites only.

The common granite has usually been employed for paving, but the system of making common roads in the metropolis instead of paved streets, seems likely to abridge its employment in that respect.

Flints are often used in the provinces for building where stone is not easily procurable, and towers and walls of considerable height and extent are sometimes built of this material. For this purpose they are broken and dressed so as to afford a tolerably smooth surface. When they are employed, the quoins and fasciæ must be composed of brick or squared stones.

The weight of a cubic foot of each of the principal species of stone used in this country, is subjoined.

	lbs.
A cubic foot of Aberdeen gray granite weighs	166½
. . . . . Aberdeen red granite . . .	165¼
. . . . . Cornish gray granite . . .	166½
. . . . . Cornish red granite	164
. . . . . Bath stone	140
. . . . . Bramley Fall stone	156½
. . . . . Collalo stone	151½
. . . . . Cragleith	150
. . . . . Derbyshire red sandstone . .	146½
. . . . . Dundee	158
. . . . . Kentish rag stone	167¼
. . . . . Portland	152
. . . . . Purbeck	165
. . . . . Roach Abbey	118½
. . . . . Yorkshire paving	156½

BRICKS AND TILES.

THE use of bricks appears to have been very common from the earliest ages, though those of the antients differed very materially from the bricks now in use. At the remotest period they appear to have been unburnt, but some have thought that the method of burning them was not even then unknown. Whether this were or were not the case, is of little importance here; our object being to inform the young architect on the method now pursued in making them, as well in the *kiln* as in the *clamp*, the best sort of clay and other materials for that purpose, and their different sorts, sizes, strength, and durability. It is to be regretted that bricks are in this country now condemned, where stone cannot be afforded, to be plastered over with various cements much to the interest of the brick-maker and bricklayer, who thus get rid of their worst bricks, from the present taste of placing them behind a coat of plaster. It should be recollected, that though colour, which is the objectionable quality in bricks, may be one of the essentials of beauty, yet that form is a much more important essential, and that they are a material adopted, even for columns, by Palladio, who has left them in some examples without a coat of plaster on their backs.

The earth used for making bricks is of two sorts. A stiff clay with little or no extraneous mixture, which produces a hard red brick. The other of a yellowish coloured fat earth, known by the name of loam, which produces a gray coloured brick. As the earths before they are wrought are much mixed with improper particles, they should undergo the action of the air through a winter's frost, to mellow and pulverise them, whereby their tempering will be facilitated. The more the clay is chafed and turned over with the spade, the better will be the bricks, and it should be perfectly free from stones. In tempering the clay, which is usually performed in a clay mill, it is, in the neighbourhood of London, the custom to mix it with sea-coal ashes. In the country, a light sandy earth is found to answer the same purpose, namely, that of making the clay work easy, and of saving fuel in the burning. In making the clay into a paste with the ashes or sand, as little water as possible should be introduced. The paste should be tough, hard, and ponderous.

When the clay is wrought and tempered, it is brought to the moulder* in lumps, rather larger than will fit the mould, which is ten inches long, five broad, and about three inches thick, being in fact nothing more than a box of those dimensions without top or bottom. The moulder, having dipt his mould into dry sand to prevent the clay adhering to it, works the clay thereinto, and with a flat smooth stick kept for the

* A handy moulder, working fifteen hours, will mould five thousand bricks.

purpose in a pan of water, strikes off the superfluous soil. The bricks thus moulded, are placed along the brick-field in rows called *hacks,* raised eight bricks on edge high, and two bricks and better in length wide, ranged diagonally one above the other, so as to give a free passage to the air. In fine weather they may be shifted in a few days, that is, turned and re-set a little more open, after which, in six or eight days, they are ready for the fire. Care must be taken during the time they are in the *hacks,* that they be protected from rain by covering them with wheat or rye straw, because it is absolutely necessary that they be perfectly dry before they are submitted to the action of the fire. In making the better sort of bricks, termed malm or marl stocks, more care is used in tempering the clay; it is also washed, and the paste, when tempered, is in a more liquid state. It is then collected into square pits, where, till settled and the water either drained off or evaporated, it remains till wanted for use.

The burning is performed in a *clamp* or *kiln.* The former, though most common, is not so good a mode as the latter, in which there is less waste, less fuel required, and less time requisite for the operation. Clamps are formed of the bricks themselves, and are generally oblong on the plan: their foundations being made with *place bricks.* Upon these the clamp is built up of the bricks intended to be burnt, as high as the size of the clamp requires; between each course of bricks is to be placed a layer of *breeze* or cinders, a layer of which is also placed on the top of the whole.

The fire-place, or places if the size of the clamp requires more than one, is usually situated on the west side of the clamp, about three feet high, and from it the flues must run through the clamp about the same height as the fire-place, and about eight inches and a half wide, covered by a course of bricks lengthwise at that height. These flues are filled with coals, breeze, and wood, pressed closely together. They must be about six feet asunder if the bricks are wanted shortly, the time required for burning in this case being only from twenty to thirty days; but if more time can be allowed, the flues may be about nine feet asunder, in which case the clamp will burn more slowly, but much more equably.

Kilns are usually thirteen feet long by ten feet six inches in width, and twelve feet in height, and with the walls, which are one brick and a half in thickness, incline inwards. A kiln usually contains twenty thousand bricks at each burning. The fire-place consists of three arches, which have holes at top for distributing the heat to the bricks. These are laid on a lattice-like floor, and first undergo a gentle action of the fire to dry them thoroughly, which is continued for two or three days. When thus rendered ready for burning, the mouth of the fire-place is dammed up with what is called a *shinlog*,* leaving above it sufficient room to introduce a faggot. The kiln is supplied with faggots,

* Pieces of brick piled against each other, and closed with wet brick earth.

heath, fern, &c. until its arches appear white, and the fire appears on the top. The heat is then alternately slackened and the fire re-made, until the bricks be thoroughly burnt, which is generally in forty-eight hours.

Bricks, when burnt, are required by the statute to be not less than eight inches and a half long, two inches and a half thick, and four inches wide. The soil required for making one million is about three thousand cubic yards.

It has been observed above, that the marl-stock brick requires much more care in tempering the clay; additional attention is no less necessary in burning it. It must not be overheated, and the fire throughout the clamp or kiln must be kept steady and equal during the operation.

The different varieties of bricks may be classed as follows; malms or marl-stocks, stocks, place bricks, fire bricks, paving bricks, compass bricks, concave or hollow bricks, and Dutch or Flemish bricks. There are still other varieties, but as they are little used there is no necessity to mention them here.

MALMS are divided into FIRSTS or CUTTERS, which are of the brightest and most uniform colour and texture. They are principally used for arches of doorways and windows, quoins, &c. for which purposes they are rubbed and cut to their proper dimensions and form. There is a red cutting brick, whose texture is similar to the malm cutter, which must not be confounded with the red stock.

SECONDS, which are not quite so uniform in colour as the former, but nevertheless handsome and durable. They are selected for facing the fronts of brick buildings.

STOCKS are RED and GREY; both sorts are equal in texture. The former are burnt in kilns. The gray stocks are less uniform in colour than seconds, and are of a rather inferior quality. They are used for common fronts and walls.

PLACE BRICKS or PECKINGS, sometimes also called *Sandel* or *Samel Bricks*, are those which, having been outermost or furthest from the fire in the clamp or kiln, have not received sufficient heat to burn them thoroughly, and are consequently soft, uneven in texture, and of a red colour. These should never be used in a building where durability or beauty are requisites.

BURRS or CLINKERS are masses of several bricks run together in the clamp or kiln, from the violent action of the fire.

FIRE BRICKS, so called from their resisting the greatest violence of fire, are of a red colour; they are made about nine inches long, four inches and a half broad, an inch and a half thick, and are of very close texture. The loam of which they are composed is yellow, harsh to the touch, and contains a great deal of sand. Their quality renders them peculiarly fit for furnaces and ovens. The greater part of those used about London, were formerly brought from a place called Hedgerly, a village near Windsor. Hence they are sometimes called Windsor Bricks.

PAVING BRICKS are for the purpose which their name implies, and their dimensions are the same as those of the foregoing sort.

COMPASS BRICKS are circular on the plan; they are chiefly employed for *steyning* or walling round wells, cesspools, and the like.

CONCAVE or HOLLOW BRICKS, are made like common bricks, but hollowed on the one side in the direction of the length, and are adapted to the construction of drains and water-courses.

DUTCH CLINKERS and FLEMISH BRICKS, are little different in quality; they are exceedingly hard, and are used for the paving of stables, yards, &c. though some object to them in the former as being too hot for the horses' feet. The former are six inches long, three inches broad, and one inch thick, and are laid on edge in various fanciful forms, as the herring-bone, &c.

Three hundred and thirty bricks well burnt may be generally taken as weighing twenty hundred weight, so that the weight of a cubic foot of brick-work is about one hundred and twenty-five pounds: and it is found by experiment that to crush a mass of solid brick-work, whose section is one foot square, a weight of three hundred thousand pounds avoirdupoise must be applied.

TILES partake so much of the nature of bricks, that it is unnecessary to explain very particularly the method of manufacturing them. The clay of which they are formed will always make good bricks, but from the toughness required on account of their being

so much thinner than bricks, the converse does not hold good. The common kinds are made of a blue clay found in many parts about London, though usually at a greater depth than brick-earth; often under the brick-earth itself. It should be dug in September and October, and lie exposed through the winter; having been turned up in the preceding month, it may be worked in February, and as in the manufacture of bricks, the more care bestowed in well beating and tempering the clay, the better will be the tiles.

They are burnt in a kiln constructed on the same principles as the brick-kiln, but with the addition of a cone having an opening at top round the chamber of the kiln. Much care is required in burning them; if the fire be too slack they will not acquire the requisite hardness; if too violent they glaze and suffer in form; it must therefore be watched and managed with care and discretion, for a slight neglect will occasion great loss to the manufacturer.

The varieties are PLAIN, RIDGE and HIP, PAN or FLEMISH, and PAVING TILES.

PLAIN TILES should be ten inches and a half long, six and a quarter broad, and five-eighths of an inch thick, according to the statute. They are made with two holes in them, through which, by means of oak pins, they hang on the laths. The number of tiles necessary to cover a square of one hundred feet superficial at a gage * of six inches and a half, is about seven hundred

* The gage of tiling means that part of a tile which appears uncovered by the next superior tile.

and forty. A plain tile weighs a little more than two pounds.

RIDGE TILES are those used to cover the ridge of a house, being nearly semi-cylindrical; they should be thirteen inches long and girt about sixteen inches on the outside. HIP TILES are of the same form.

GUTTER TILES, for the valleys of a roof are now rarely used, having had their place long since supplied by lead.

PAN or FLEMISH TILES, are mostly used for the covering of sheds, leantoes, &c. and are useful where the roof is pretty flat. They do not answer for a steep pitch, having no holes for pins, as plain-tiles have; they are prevented from sliding down from their laths by means of a knot of their own earth on their underside nearest the ridge; and on their section are of contrary flexure, thus They are often glazed and should be fourteen inches and a half long and ten and a half broad.

A square or one hundred feet superficial requires about one hundred and seventy tiles, and they are usually laid to a ten-inch gage.

The largest sort of paving tiles are a foot square and one inch and a half thick; the next size, called ten-inch tiles, are only nine inches square, and one inch and a half thick.

SLATES.

SLATE is a species of argillaceous stone. That species in which the architect is interested is the schistus tegularis: it is so soft that it may be slightly scratched with the nail, and is of a brittle lamellated texture. It consists of argyll, earth, silex, magnesia, lime and iron; of the two first and of the last in considerable proportion.

Several species are in use about London, reducible however to two sorts, the common blue slate and the purple slate. They are all found in many parts of England, lie generally near the surface, and, besides the splitting grain by means of which they are cleft of the smallest thinness, are mostly divided into *stacks* by breakings, cracks, and fissures. The Gray or Horsham Slate is rather stone than slate, and, on account of its weight and thickness, inferior to the other sorts.

Slate is applied to the purposes of paving, ledgers for graves, and to various other uses, in the neighbourhood of quarries, and has a singularly neat and beautiful appearance. Soundness and fineness in texture being its most desirable properties, and the expense of slating being enhanced by the value of the boarding whereon it is laid, which soon becomes rotten if the slate imbibe and retain the wet, it is of importance to try its

qualities, unless we are thoroughly aware of the goodness of character of the quarry whence it is brought. A good slate is nearly as durable as lead. To judge of its goodness strike it as you would a piece of pottery to ascertain the soundness thereof; if it yield a sonorous clear bell-like sound it is a sign of excellence; a trial on many pieces of the slate should be used before coming to a decision. It is a good sign if, in hewing, it shatters before the edge of the zax;* it may be also judged of in some degree by its colour; the deep black blue sort being more liable to imbibe and retain moisture than that sort which is of a light blue colour. The touch is also some criterion, though in a small degree; a good firm slate feels hard and rough, whereas an open slate feels smooth and greasy. There are two other ways of trying slate: the first whereof is to set several pieces of the slate edgewise in a tub of water, the water reaching about half way up the height of the pieces; if they draw water and become wet to the top in six or eight hours' time, they may be considered spongy and bad, but if only an inch or two above the level of the water is wetted, the contrary. The other way is to weigh pieces of the slate; then carefully noting the weight, immerse them and let them remain in water twelve hours; take them out and wipe them dry, and if they weigh more than they did previous to their immersion,† the sample should be rejected. It is the absorption of the rain by slates that is so injurious

* An instrument used in quarrying slate.

† A drachm in twelve pounds is allowable.

to the wood-work under them. If, as has been observed, the character of the quarry be not known, let such experiments never be omitted, for the eye is too often deceived, and in nothing more easily than in slates, whereof the expense is too considerable to omit any precaution.

No covering, copper excepted, is more light, lasting, or beautiful, than slate. In real economy they must be ranked after lead and copper.

The different sorts of Slates in use by the London workman are here subjoined in order of the quality.

WESTMORELAND SLATES. They run from three feet six inches to one foot in length, and from two feet six inches to one foot in breadth. A ton of them will cover about two squares and a quarter. They require to be nailed with sixpenny and eightpenny clout-nails at the least, which should be of copper, for iron nails soon decay.

WELCH RAGS are second in goodness, and run nearly of the same size as the last; a ton covers about a square and three quarters. IMPERIALS run from two feet six inches to one foot in length, and are third in rank. DUTCHESSES hold about two feet long, and are generally nailed to a ten and a half inch gage. COUNTESSES cover about three squares to the ton. LADIES are bought by the thousand of twelve hundred, which quantity covers about four squares.

There are still other sorts of slates, as the DENNY-BOLE, &c. The TAVISTOCK also, which are bought by the thousand of ten hundred; a thousand whereof will

cover about three squares and forty feet; a sort also called DOUBLES which is the smallest in use.

A patent was some years since taken out for slating buildings without the use of boarding underneath them. In this the slates are all reduced to the same width, and screwed to the backs of the rafters; over their inclined junction, on the backs of the rafters, slips of slate one inch and a half or two inches wide are laid and bedded in red putty to prevent the entry of the rain. This sort of slating, though it has a handsome, regular appearance, has latterly been abandoned, from the disorder which is occasioned in it by the slightest partial settlement of the building, as well also as from the liability of the putty to be injured and fall away by the effect of the sun on its surface.

The bond or lap of a slate is the distance between the nail of the under slate and the lower end of the upper slate, and the gage is the depth of the slate visible.

LIME, SAND, WATER AND CEMENT.

LIME is found always united to an acid, as to the carbonic acid in chalk. By exposing chalk to a red heat the acid is driven off, leaving the lime in a state of purity, which is then called caustic or quick lime. It dissolves in six hundred and eighty times its weight of water.

In this country the use of marble for burning to lime would be too expensive: we shall therefore confine our observations to the lime burnt from the lime-stone abounding in the provinces, and from common chalk.

The varieties of lime-stone are, the Compact; the Foliated; the Fibrous; and the Pea-stone.

Compact lime-stone is of various colours, grey, for instance, smokey colour, yellowish, blueish, reddish and greenish; where any of these colours are mixed it is called marbled. It is found mostly massive, frequently composed of extraneous fossils, particularly shells; internally dull; texture compact; fracture small, fine and splintery; fragments indeterminately angular; more or less sharp edged; semi-hard; sometimes soft; brittle; easily frangible; its specific gravity varies from 2·500 to 2·700, and it is composed of lime, carbonic acid gas and

water; mostly with a portion of argyll and oxyd of iron, and sometimes of inflammable matter. The other varieties are, the foliated lime-stone, such as calcareous spar; granular; statuary marble, &c. The fibrous lime-stone, such as satin-spar, &c. The pea-stone, another species of spar*.

Before burning any of these for lime, there is no external character by which the simple lime-stones can be distinguished from the argillo-ferruginous ones; but the former, whatever be their colour in a crude state, become white when burnt, the latter possess more or less a slight ochrey tinge. Brown lime is much the best for all kinds of cements, but the white varieties being more abundant are more general in use. To those uninformed on chemical operations, it may be useful to know, that every stone which will ferment with an acid, as aquafortis, is capable of being burnt into lime, but the harder the stone the better the lime. Chalk is not so good as stone, for reasons which will be hereafter given, that of shells the worst: neither should be used for work under water.

In England our lime-stones are generally of a red or blueish cast, and it behoves the architect, when he has the power, to choose that which is sound, firm, weighty, and uniform in texture. It is best when broken from large rocks and beds which lie on the sides of hills;

* The various kinds of marble, chalk, and lime-stone, may be divided into those which are nearly pure carbonate of lime, and those which, in addition, contain from one-twentieth to one-twelfth of clay and oxyd of iron.

those newly taken and deepest dug are to be preferred. Thus Palladio properly recommends them to be dug in preference to picking them off the surface.

Lime-stone loses four-ninths of its weight by burning, though it shrinks but little; when fully burnt it falls freely into powder on slaking, and gives about double the bulk it occupied before that process. It is burnt in kilns, which are generally of a form circular on the plan, and in section an inverted frustrated cone, latterly, however, the shape has been spheroidal. In either case the heat is applied at a fire-place under the lime-stone, which is kept in its position at the bottom by bars, which, when the kiln is a perpetual one, egg-formed, or a draw-kiln, are susceptible of removal to let out the lime as it is burnt, the deficiency of which is supplied by fresh stone at the top of the kiln. Lime is also burnt in *sod-kilns*, which are made by excavating the earth in the form of a cone, and then building up the sides as the earth may require. In this case the lime-stone is laid in with alternate layers of fuel to the top of the kiln, and the top being covered with sods to prevent the escape of the heat, the fire is lighted, and the lime-stone burnt, and not removed till thoroughly cool. This is a tedious process, and expensive from the quantity of fuel consumed. In the common kiln the fire is never extinguished; fresh lime-stone being supplied as the well-burnt is removed. Where lime-stone is calcined with peat, the kilns are denominated *flame-kilns*, in which bricks are generally burnt with the lime.

Lime-stone, to reduce it to lime, requires burning about sixty hours, with a good well regulated heat; but the various species will of course require different periods of time. The main object in burning is to expel the carbonic acid gas which enters into its composition.

Lime which slakes the quickest and heats most in slaking is best, this also falls into the finest powder; if it contain many coarse lumps of core that do not pass through the screen, it is a sign either that the stone has not been sufficiently burnt, or that it contains extraneous matter, which will not only render it inefficient, but also more costly in use.

The experiments of Dr. Higgins and Mr. Smeaton have proved, that if chalk and stone-limes be used equally fresh, their cementitious properties will be equal; but as quick-lime absorbs carbonic acid with greater or less rapidity, in proportion to its spongy or solid texture, so it gradually parts with its cementing nature, and at length becomes totally unfit for the purpose of mortar. Hence, though stone and chalk-limes be equally good when perfectly burnt and fresh from the kiln, yet there is an important practical difference between them, because the latter takes in the carbonic acid with much greater facility than stone-lime. In the metropolis, there is now no excuse for the use of chalk-lime, except for the commonest purposes. It is received from Kent and Essex, and often lies at the different wharfs under open sheds long enough to lose every good property it originally possessed: whereas

the stone-lime may be had at a short distance from the metropolis, not only in abundance, but of the best quality.

The lime, when slaked, must be passed through a sieve so as to leave only a fine powder; this is usually performed by means of a screen made of wire, set at an inclination to the horizon, against which the lumps of slaked lime are thrown. That which ought passes through it, the remainder or core falls on the side of the screen against which the lime is thrown. For mortar the core must be entirely rejected; it is, nevertheless, excellent as dry rubbish for filling in the sides of foundations, under wood floors, where they would otherwise lie next the earth, and the like. The sifted or *screened* lime is now added to the sand, whose proportion to the lime must vary as the strength of the latter. It is however most important that the lime and sand be well tempered and beat together after the water is added to them, and the better this is effected the smaller will be the necessary consumption of lime. For this purpose, what is called a *pug-mill*, is the best calculated, being of the same nature as the clay-mill used for making bricks. When, however, this is not at hand, it should be well tempered with wooden beaters, and turned over repeatedly, so as to be thoroughly well mixed. This is an affair of no small consequence, because as the sand being by far the cheapest article of the two, it will be profitable to use as large a proportion of it as can with propriety be admitted. It is also to be noted that when the sand

predominates, less water is required, and the mortar therefore sets sooner; the work, moreover, settles less, for as the lime will shrink in drying, while the sand continues to occupy the same bulk, it follows that the thickness of the mortar-beds will be less variable. In general no more lime is required than is necessary to surround the particles of sand.

In London, with the common chalk lime, it is usual to mix one hundred and a half, that is, one hundred and fifty pecks or thirty-seven and a half striked bushels with two loads of sand*; but with stone-lime one hundred to two and a half loads of sand is enough. Each of these proportions will give mortar sufficient for a rod of brickwork, which is a superficial measure of two hundred and seventy-two and a quarter square feet of one and a half brick or fourteen inches in thickness. When the tempering, however, is not well attended to, the first-named in the proportion of one hundred, or even less, of lime to two and a half of sand will suffice, and in respect of the latter, it has lately become, and properly, the practice to mix one hundred of lime with three and even four loads of sand. Dr. Higgins, in his experiments, goes so far as to recommend seven parts of sand to one of lime. The experiments of the laboratory, however, are not always proper foundation for practice.

SAND should if possible be procured from a river in

* A load of sand is thirty striked bushels.

preference to a pit. It is cleaner and not so liable to be found connected with clayey or muddy particles. If the latter enter into it, it will never indurate sufficiently. River sand is washed out or up from the banks or bed of the river, and is usually thence known by the name of SHARP-DRIFT SAND. If pit sand only can be procured, it should undergo repeated washings till it become clean, of a bright colour, and feel gritty when rubbed between the fingers. If sea-sand be used, Smeaton advises that it be well washed in fresh water to dissolve the salt, otherwise, he says, the cement will never dry sufficiently.

WATER, the medium through which the other ingredients of mortar are incorporated, should be soft and pure. Dr. Higgins recommends lime-water for this purpose. The screened lime and sand are shovelled and mixed together, then the water is added, the less in quantity the better; afterwards it is tempered by beating and chafing or by passing through a pug-mill, as above mentioned.

When mortar is made, it should be used immediately, that is, supposing the lime to have been well burned. In respect of that used by plasterers, who employ an inferior lime, it is the practise to make a large quantity of mortar at a time, and either bury or cover the fresh lime with a yard or so in thickness of sand, and then pour on as much water as will slake it, but not reduce it to dust. If the sand open, and the smoke rise through the openings, these should be closed up

and kept fast without vent. The lime will be thus preserved, and there is a greater chance of its getting thoroughly slaked, for be it observed that the small bits of unslaked lime, not having had sufficient time given them, burst out and crack in the face of the plastering, and occasion the blistering so often the subject of complaint. This sort of mortar never attains the hardness and durability necessary for external work.

GROUT or Liquid Mortar is nothing more than common mortar made sufficiently fluid to penetrate the narrow irregular interstices which common mortar from its consistency will not reach. The mortar whereof it is made should be thoroughly beat, and it may be kept a little longer, whereby its quick setting will be facilitated.

CEMENT. So far with respect to common mortar: but in works under water it is necessary to use a cement that will harden quickly in those situations, which common mortar will not do, though it may stand the water well enough when entirely dry, and set. No cement answers the condition so well as that known by the name of Parker's cement, which is burnt from a lime-stone found on the Isle of Sheppey. This becomes, in a few minutes, exceedingly hard, either in or out of the water; and wherever the work is exposed to agitated water, the outer beds should be laid in this cement. In many parts of England a lime-stone is found which, when burnt and used in mortar, gives it the property whereof we are speaking. The best species of these

lime-stones is the Aberthaw from the Welch side of the Bristol Channel. Mr. Smeaton found the stone of Watchet, in Somersetshire, also excellent in this respect, and traced it through the counties of Monmouth, Worcester, Leicester, by the Vale of Belvoir into Nottinghamshire, in Lincolnshire at a place called Long Bennington, also in the counties of Dorset, Hants, Sussex and Surrey; in Lancashire it goes by the name of Sutton Lime. When burnt all the water lime-stones fall into a buff-coloured tinge, and contain a considerable portion of clay. If neither of these can be procured, burnt and pounded iron stone, scales from an iron forge, hard burnt tiles, ground and mixed with quick lime, all become hard under water and in damp situations. In the composition of cements advantage has been derived from using water which contained a solution of iron of a dark red colour approaching to black. Clean sharp sand whose particles are angular must likewise be used; gravel small and well washed will do in rubble work.

Pozzolana and Dutch Tarras are now little used in this country, Parker's cement having superseded them. The Mastic, an oil cement, invented near a century since by P. Loriot, for which, extraordinary as it may appear, a patent has been recently granted, is only fit for coating buildings, but it is far inferior to Parker's cement, as also to one for which a patent has lately been granted to Mr. Chambers.

GLASS.

GLASS is a combination of silex with fixed alkali; the alkali generally employed is soda. This mixture when calcined is called frit; after complete fusion it becomes glass metal, and the salts floating on its surface are vulgarly called glass gall. After being formed into the requisite shapes, it is annealed or tempered by being placed in a furnace of appropriate heat; its fineness depends on the purity and proportion of the ingredients. A fine crystal glass is obtained from sixteen parts of quartz, eight of pure potash, six of calcined borax, three of flake white, and one of nitre. The specific gravity of glass is about 2·60; of French plates 2·84; of English flint glass 3·32. Among the properties of glass it is to be observed, that it possesses very great elasticity, and is less dilatable by heat than metallic substances.

WINDOW or TABLE GLASS is blown in circular plates, varying from three feet six inches to four and five feet diameter. It is made as follows: the workman having a sufficient mass of melted *metal* or glass on his *blow-pipe,* blows it out into a pear-like form, the end or point of the pear being next to the blow-pipe; when sufficiently large, which from experience the workman well enough determines, an assistant with more metal at the end of a long cylindrical iron bar, termed a *flashing rod,* applies it to the end of the pear-like figure

so as to join it thereto, and at the time of applying it, the man who has the blow-pipe cuts it off on his side, so as to disengage it from the blow-pipe; the vessel, for so it must be called, is now open at one end, and fixed to the flashing rod, is gradually opened by a tool into a bell-like figure, being occasionally applied to the mouth of the furnace to preserve its ductility; when sufficiently opened, it is again applied to the mouth of the furnace, and while there, is kept revolving on the flashing rod till it spreads itself perfectly flat and circular. The table of glass thus formed is then disengaged from the flashing rod, leaving a thick knob in its centre, and is placed in a certain part of the furnace to be annealed. When the table is cut for use, the centre part with the knob in it is called *knob glass,* and is used only in inferior situations. Tables of glass are now made so large that squares may be procured thirty-three by twenty-five inches and even upwards.

There are three qualities of this sort of glass in common use, viz. best, second, and third glass; the last is usually of a very green hue, and is only employed for very common buildings; they are all sold by the *crate,* which is always the same price, the difference being made up by varying the number of the tables that it contains; thus, a crate of best crown glass contains twelve tables, seconds fifteen tables, and thirds eighteen tables.

There is no longer a glasshouse in the metropolis at which this species of glass is made. Formerly there was one at Lambeth, and another at Ratcliffe, but they

have long since ceased on account of the disadvantage of manufacturing in a metropolis where fuel is so dear. Bristol, with Newcastle, and some other places in the north, are now the chief places of its manufacture.

GERMAN SHEET GLASS can be had of large dimensions, and is an excellent sort; from the exterior it has an uneven, and perhaps unpleasant appearance, which within the building is not perceptible.

PLATE GLASS, far excelling all the other sorts in quality, substance and flatness of surface, is cast in plates and polished afterwards; this sort can be had of almost any dimensions.

METALS.

IRON, of these, claims our first attention; it is of a blueish white colour, very hard and elastic, malleable, exceedingly tenacious and ductile; susceptible of a fine polish, and capable of acquiring an increased or diminished degree of hardness by certain chemical processes, more than any other metal. It requires a very intense heat to fuse it, and cannot therefore be brought into the shape of tools and utensils by hammering. It possesses another valuable property which, among the other metals is found in platina alone, namely, that of welding or uniting smaller into larger masses.

Iron is diffused over nearly the whole globe, and is the most abundant of metallic substances. Few mineral bodies or stones are found without a proportion of this metal in them. It has been discovered, though rarely, in a native state in Siberia and the interior parts of South America. Most iron is found in the state of oxide, in ochres, in bog ores, and other friable earthy substances of a red, brown, yellow or black colour. Sometimes whole mountains are composed of iron stone, whereas other metals usually run in small veins.

The richest ores of iron are compact and ponderous, of a brown, reddish-brown or black colour; some of them in appearance are not much unlike iron itself;

such are the gray ores of Derbyshire and the blueish ores of Gloucestershire. Most of the Swedish ores, the iron whereof was in this country so much prized till we were properly aware of our own treasures, are likewise of this kind. The most common ores here are: 1st, The Lancashire ore, which is very heavy and of a fibrous lamellated texture; colour dark purple, approaching to a shining black which, when reduced to powder, becomes of a deep red. It lies in veins like the ores of other metals. 2nd, The bog ore, resembling a deep ochrey yellow clay, which appears to be the deposit of some ferruginaceous rivulets that have passed over the plains in which it is found. It lies in beds of irregular thickness, usually from twelve to twenty inches, varying in their breadths from side to side, and rarely if ever of equal dimensions. 3rd, The iron-stones which have no regular appearance, and do not at all resemble metal in their external surface. They often lie in beds of very great extent like other stoney matters, and are sometimes stratified with seams of pit coal forming alternate layers.

Iron is obtained from the ore by a process called *smelting*, and after such process is termed crude, cast or pig iron. In the large iron works the iron ores are usually calcined or roasted previous to their fusion, for the purpose of expelling the sulphureous or arsenical parts, so as to render them more easily frangible into pieces of a convenient size for melting. These are placed in large furnaces of various shapes, ten to fourteen feet wide, and from sixteen to thirty feet in

height. The best shape of them has been considered that of a hen's egg with the largest end downwards, below which is a square cavity to contain the melted metal. At the top is a short vent about twenty inches diameter; the inner part built of fire-stone, is surrounded by other walls deviating from the circle, ending at last however in a circular building about twenty feet at the base and converging towards the top. Near the bottom of the furnace is inserted the nozzle of a large pair of bellows worked by water, steam or other machinery, for the purpose of introducing a strong current of air upon the inflammables used in the operation. At proper places holes are left at the bottom of the furnace to be occasionally opened for letting out the scoria and metal as occasion may require. Charcoal or coke with lighted brushwood is first thrown in, and when the inside of the furnace has acquired a great heat, the ore is superadded in small quantities with more fuel, and generally a portion of lime-stone as a flux. The ore gradually subsides into the hottest part of the furnace where it becomes fused. The metallic parts being received by the coal, pass through the scoria, and fall to the lowest part, where a passage is open for taking off the scum or dross. The metal now in fusion is let out by a tap hole into furrows made in a bed of sand. The large mass which *sets* in the main furrow the workmen call a *sow*, and the lesser are called *pigs* of iron. The iron thus obtained is far from pure, neither is it malleable, though its quality varies considerably according to the quantities of fuel,

the additions made, and the regulation of the heat. It is therefore re-melted in another furnace, re-mixed with charcoal, and by the impulse of a strong blast of air on the surface of the metal, its fusion is promoted. The iron then thickens in a mass called a *loop*, and is conveyed to the action of large hammers, usually raised by the motion of a large water-wheel. Beaten into a thick square form, it is again heated till approaching fusion, and then forged. This process is repeated till it becomes quite malleable, when it is formed into bars for sale. The cast iron has of late years been rendered malleable by passing it through rollers instead of forging it. In this process the raw or cast iron is freed from the impurities which often remain after the common method of rendering it malleable has been used. The sea coal only is used in it, and the iron is simply heated by the flame, instead of being mixed with the burning fuel and ashes. To enter into a minute detail of the various operations relating to the smelting of iron is beyond our limits. A visit by the architect to some of the principal smelting houses would be highly serviceable to him.

The founding of iron may be well enough observed in the metropolis, though not on so large a scale as elsewhere. Cast iron is now much in use, and has been applied in some way or other to almost every purpose. We have cast iron roofs, bridges, and the like; but in these cases, unless on the spot where it is cast, and where the cost is little more than the ore and the fuel, it is a much dearer article than wood. As a substitute

for stone in the arches of bridges, it is so unarchitectural in appearance that one may incline to think the architect, if left to his own choice, will never adopt it; and in many instances, experience has taught us that a few years, and partial settlements, make it much more inexpedient than stone. Cast iron is useful for sash weights, square balusters, iron railing, &c.

Wrought iron, when used, should be well hammered; it is employed for window bars, chimney bars, hinges, latches, bolts, cramps, chain bars, nuts, screws, and infinite other purposes. As in all the instances where iron is used, much reliance is placed on its strength, the utmost care should be taken that it be well hammered and forged.

The specific gravity of cast iron is 7·200, a cubic foot, therefore, weighs four hundred and fifty pounds; of hammered wrought iron 7·763, and a cubic foot weighs four hundred and eighty-five pounds.

COPPER was amongst the first metals employed in building by the early nations of the world. It is neither scarce nor difficult to work and extract from its ores. When pure, is of a pale red colour, its specific gravity 8·600, and a cubic foot weighs five hundred and thirty-seven pounds and a half. These latter, however, vary as it is more or less hammered. Its elasticity and hardness are considerable; it is extremely malleable, and may be reduced to fine leaves. Its tenacity also is great, inasmuch as a wire of it, one-tenth of an inch in diameter, will sustain three hundred

and sixty pounds without breaking. The most celebrated copper mine in this country, though the ore abounds in Cornwall and other parts, is the Parys mine in Anglesea, which affords chiefly the yellow sulphuretted ore of copper, amounting annually to from forty thousand to eighty thousand tons. The ore generally contains from twenty-five down to one and a half per cent. of copper, is partly dug by packages, partly blasted by gunpowder, and afterwards broken by hammers into small pieces preparatory to its being roasted; an operation now performed in kilns, in shape resembling lime kilms, having contrivances by which the ore can be removed as it is roasted, and fresh ore added. The kilns are arched level with the top of the ore, and adjoining and communicating with the kiln is the floor of a condensing chamber, which receives the sulphureous vapour of the kiln, and falls down therein in the form of the finest flowers of sulphur. The quantity of ore put in at one time amounts to several hundred tons, and six months are required to complete the operation. The ore after roasting, by which it is reduced to one-fourth of its former quantity, is washed and pressed to free it from its impurities. The richer ores are then dried and sent off to be smelted and refined in reverberatory furnaces, from which it is at length brought in short bars or pigs. The water which filters through the crevices of the mines is often highly impregnated with sulphate of copper, and in water pumped up from the bottom of the mine into rectangular pits, about thirty feet long, twelve feet

broad, and two feet deep, together with the water in which the roasted ore has been washed, are immersed pieces of iron, which combine with the sulphuric acid, and precipitate the copper in the form of a reddish powder, slightly oxidated. This precipitate generally gives about fifty per cent. of pure copper, and is more profitable to the worker than even the metal which is produced from the crude ore.

The sheet copper, which forms so admirable a covering for roofs, is extremely durable, and is reduced to sheets by being passed through large rollers, so that it may be made of the smallest thinness. Those however generally used are from twelve to eighteen ounces avoirdupoise to the superficial foot. Copper exposed to the air soon loses its lustre; it becomes tarnished, and of a dull brown colour, which gradually deepens till it is converted into that of bronze, and at last acquires a green rust or calx, which does not, like the rust of iron, corrode its internal parts, but is confined to the surface, and instead of destroying, tends rather to the preservation of the metal. The antiquarians call this crust *patina;* but the Italians have a method of imitating it so as sometimes to deceive the most experienced.

Copper is extremely well adapted for cramps to stone work, especially when exposed to the air, but where the water from a roof is to be saved for culinary purposes, copper must not be used, nor should the vessels into which it is conveyed, as reservoirs, be of that metal unless tinned inside. Alloyed with zinc it forms brass

for the handles of doors, locks, drawers, shutters, and the like. One part of zinc to three of copper is the usual proportion. It is of a fine yellow colour, and more fusible than copper, less liable to tarnish from exposure to the air, very malleable and ductile, can be beat into thin leaves, and drawn into very fine wire. Its specific gravity is greater than those of the two metals whereof it is composed. The extremes of the highest and lowest proportions of zinc, are from twelve to twenty-five per cent. of the brass. Even with twenty-five per cent. of the zinc, if it be well manufactured, it is quite malleable, though zinc itself scarcely yields to the hammer. The appearance of brass is often given to other metals by washing them over with a yellow lacquer or varnish, a practice very often resorted to. Copper sometimes, with a little zinc in the proportion of from one-tenth to one-fifth of the whole, forms a composition called bronze or bell-metal, and is used for founding statues, bells, cannon, &c. When the tin is nearly one-third of the alloy it forms a beautiful white close-grained brittle metal, susceptible of a high polish, used for the specula of telescopes.

LEAD is produced in most parts of the world; it is of a dull white colour inclining to blue, the least ductile, elastic, and sonorous of any of the metals: its specific gravity is from 11·3 to 11·479, and a cubic foot weighs about seven hundred and ten pounds. Incapable of being drawn into fine wire, though easily extended into thin plates under the hammer. Lead, though

sometimes, is rarely found native. The ore often contains silver; it is bright, blueish, has much of the appearance of the metal, and is easily reduced to the metallic state by fusion with charcoal, an operation, from the extremely pernicious vapour of the lead, very destructive to those employed in it. Even the fumes falling on the grass in the neighbourhood, render that poisonous to the cattle grazing it, and the fish in waters near the smelting houses soon die. Lead is not much altered by exposure to air or water, though it soon tarnishes and contracts a white rust, which defends the internal parts from corrosion, like that of copper. It is not, however, altered by pure water, hence the white crust on the inside of lead pipes through which water runs must be owing to some saline particles in the water. Lead unites with most metals; iron is, however, one exception. It comes from the furnace in large lumps called pigs, and from these it is run into sheets, pipes, &c.

Sheet lead is either cast or milled; the thicker kind, or common cast sheet lead, is made by casting it on a long table from eighteen to twenty feet in length, which has a rising edge all round it, it is covered with fine sand pressed, beat and smoothed down with a strike and smoother's plane. The pig lead, which is melted in a large vessel near this table, is then ladled into a pan, in the form of a concave triangular prism whose length is equal to the width of a sheet, and is poured on to the table or mould. The thickness of the sheet is determined by the space left between the

surface of the sand and the strike which bears upon the rising edges of the table, and strikes off the superfluous thickness of lead before it has had time to cool. Thin sheet lead is cast on linen cloth spread over one of woollen, and stretched on an appropriate table. In this case the heat of the lead before spreading it on the cloth, must be less than will fire paper, otherwise the cloth will be burnt. The strike is then passed over it with considerable rapidity.

Milled lead is first cast into sheets eight or ten feet long, and of such width as the rollers through which it is to be passed or milled will allow, and from two to three, four, and five inches in thickness. It is then, by the mechanical action of rollers, made to pass through them, and the distance of the rollers from each other is gradually lessened till the sheet is of the required thickness. The prejudice which long prevailed against milled sheet lead has subsided, and it is now generally admitted that milled lead for the prevention of leakage is far superior to cast lead, in which there are often pin holes, from which follow the most serious consequences.

Sheet lead of both sorts is used in covering churches and large buildings, for gutters, the hips, ridges, and valleys of roofs, the lining of cisterns, &c. The thickness varies from five to twelve pounds in weight to the superficial foot, according to circumstances.

Leaden pipes are either cast or bent and soldered. The mould is in casting made of brass, having a core of iron supported loosely down the middle of it, at such

distance from the mould as is equal to the thickness of the pipe. In those that are soldered, the sheet lead is rolled round a core of wood, the edges are then brought together and joined with a mixture of two parts lead and one part tin, called solder.

Cames of lead are made for the glaziers' mill. They are slender rods twelve or fourteen inches long, and receive on their upper and under edges, by their passage through the mill, those grooves into which the small panes or quarries of glass are inserted in common lead-lights.

Of the other metals it is unnecessary to say any thing, from their circumscribed use for architectural purposes.

SECTION II.

OF THE

METHODS OF COMBINING THE PRINCIPAL MATERIALS.

FOUNDATIONS.

THE most important duty of an architect is to take especial care that the foundation of his building be laid either on a natural or artificial solid foundation. The best ground for a foundation is that which consists of gravel or stone; but, reliance is not to be placed on what appears on the surface or near it; pits should be sunk and wells and sewers for drainage made, by which he will ascertain its precise nature. Rock, to a proverb, is the surest foundation; but we should learn whether there be hollows and shakes in it before we trust to it. If the soil be gravel, the thickness of its bed should be observed, and the strata that lie under it: if it be thick, and the under strata sound, it requires no artificial means except ramming down with heavy rammers. When clay, sand, common earth and rotten boggy ground occur, piles are required to be driven, or at least very solid planks and sleepers laid, or, what is

better, long solid pieces of stone crossed with a course of Yorkshire paving; perhaps either of the latter would be sufficient where the clay is very sound, though it will expand and contract at times so as to produce alarming settlements in a building; as also in the case of a very dry hard sand, when supported by good under strata. The nature of a foundation differs according to the intended edifice. If there be cellars and vaults underneath, the foundation is to be dug to the whole extent of the building; if not, trenches only are cut where the walls are to be raised.

As the walls are carefully proportioned in strength to the weight of the intended superstructure, so should the depth of digging for them and their height be proportioned to the same; the depth usually a sixth part of the height of the building, and the thickness of the walls twice that of those that are raised upon them. If the outer walls require piling or planking, the same should be used to the internal walls, to prevent partial settlements; of course fewer will be necessary from their bases being less extensive, but they must, nevertheless, receive equal attention with those of the outer walls. The ground being prepared for the foundation, the bottom or floor of the foundation must be made perfectly level. The Italians always begin with laying over it strong oak plank, on which they place the first course of materials. Whatever mode however is adopted, every thing should be laid with the greatest precision, by rule and line. If planking be used, the first should be a course of stone laid without mortar, for lime

would have a tendency to destroy the wood, which, otherwise, if in a soil either constantly wet or constantly dry, will last for ages. The courses should be raised above each other with evenness and regularity. If they are of brick the mortar should be sparingly used, and the joints all made with the utmost view to good bond; if stone be used, it should lie on its bed in the same direction as it did in the quarry, or it will be liable to split.

In some foundations inverted arches may be used, which will cause a saving of materials; and where piling is adopted, the security will not be lessened. Inverted arches should be turned under openings, especially where the voids are great and the piers heavy, by which means an equal bearing is better distributed over the foundations.

STONE WALLS.

THE footings should be constructed with large square stones; each course ought to be equally thick in every part, and the vertical joints of one course should fall as near as may be over the centre of the solid stones under them. In the lower courses it is advantageous to have a great portion of the stones, all indeed, if the stone will allow of it, running right through the thickness of the wall: at all events, if these cannot be procured, it will be proper to alternate the headers and stretchers on both faces of the wall, so that it may be well united in the direction of its thickness; thus the header on one side will back against the stretcher on the other side, and so on. Joints down the centre of the wall should be as much as possible avoided. The footings should, as each course rises, be about four inches on each side less than the inferior course, and their number must be regulated by the height of the wall and the size of the stones employed.

Rubble Walls are built, sometimes with, and sometimes without mortar. When they are built in courses the stones are dressed; but an equality of height in the different courses is not usually attended to.

Walls are most usually built with what is called an *ashler facing*, which is backed either with bricks or inferior stone work. The former is most common in

and about the metropolis, where brick is more economical than stone. It is evident that this practice arises from the desire to give beauty to the exterior surface of the work. It is the worst species of walling, and in point of strength far inferior to a common brick wall, from the quantity of mortar used on the inside joints far exceeding that on the outside. It follows, therefore, that if brick or rubble backing is used, the mortar joints should be kept as close as possible.

For ashler facing, the stones usually run from twenty-eight to thirty inches in length, a foot high, and nine inches thick. It is no advantage that the back and front of each stone be parallel: on the contrary, if the backs are all inclined, and the stones laid so that the inclinations are all in the same direction, it will give a lap, and thus create bond when the next course comes over it. Neither is it necessary that the adjoining stones be of the same thickness; a thick and a thin one may be set against each other with great advantage to the work. In every course of the work a number of bond stones, in proportion to the length of the wall, ought to be introduced, each of which should be placed over the middle of two bond stones in the course below. In the jambs of windows and doors every alternate stone must go entirely through the wall with their beds perfectly level. When architraves are wrought on them, they are often in one block: all the stones which adjoin them should be bond stones, and when the piers between the windows are narrow, no other bond stones will be necessary. The sides of bond

stones should be parallel and perpendicular to each other, and they should never be less in width than their height. The stones of an ashler facing should be laid on their natural beds, which will prevent flushing at the joints.

OF BRICK WALLS AND BOND.

BRICK walling is so much more in use in this country than that of stone or any other species, that it is necessary to enter at some length into an inquiry of the best and strongest mode of laying bricks, the different sorts of which have been already described.

ENGLISH BOND is that disposition of the bricks wherein the courses are alternately composed of *headers*, or bricks laid with their heads or ends towards the faces of the wall, in one course, and in the superior or inferior course of *stretchers*, or bricks with their lengths parallel to the faces of the wall. All the brick buildings in this island, whose date is anterior to the reign of William and Mary, or somewhere about that time, are constructed with English bond. In this sort of work the outside of the wall presents the appearance of a course of bricks whose small ends or heads are in the face, and hence called a *heading course*, binding the wall together in a direction at right angles to its face, alternated with a course termed a *stretching course*, which binds the parts of the wall together in a longitudinal direction. FLEMISH BOND is that disposition of the bricks wherein the same course consists of headers and stretchers alternately. It was formerly the practice to make the fronts of the walls of houses of gauged or rubbed bricks, which being thus reduced,

and laid with a flat thin joint, caused a want of correspondence in the height between the outer and inner work, but where the courses fell even, a header was generally inserted to tie or bond the front to the internal work. Thus a two-brick wall, if faced on both sides, became little better than three thin walls, the two outer each four inches and a half thick, and the middle one nine inches thick. Those bricklayers who have little regard for their character still execute their work on this principle, and where a wall is faced with superior bricks it requires the utmost attention to prevent them from cutting the headers in half, in order to effect a paltry saving in the expenditure of the better material.

In building brick walling, two points necessarily press on us. The first, that the wall be as strong as possible in the direction of its length; the other, that it be so connected in the direction of its thickness, that it be not capable of separating in that direction, or, in other words, that in the latter respect it consist not of two thicknesses.

To produce the greatest strength in the direction of the length, independent of extraneous aid, such as that afforded by bond-timber, plates, &c., it must be evident that the mode which gives the greatest quantity of longitudinal bond, as in the thickness that which gives the greatest quantity of transverse bond, is to be preferred. Now, in a piece of walling four bricks long, four bricks high, and two bricks in thickness, constructed in English bond, there will be thirty-two

stretchers, twenty-four headers, and sixteen half headers to break the joint, or prevent one joint falling over another; whereas in a piece of walling of equal size, constructed in Flemish bond, there will be only twenty stretchers and forty-two headers: thus giving the English bond an evident superiority in the direction of length, and shewing its inferiority in transverse strength. Expedients have been adopted to give the Flemish bond greater strength in its longitudinal direction, but none are sufficiently effectual to prevent the wall opening in the vertical joints, where there are great inequalities of pressure upon different points of it; under these circumstances the old English bond is unequivocally recommended, though the other has a more pleasing exterior, at least as some persons think.

In both species the length of a brick being only nine inches, and its width only four and a half, in order to break joint vertically at the end of the first stretcher from a quoin, it is necessary to interpose a quarter brick, or bat, called a *queen closer*, in order to preserve the continuity of the bond. The bond may, however, also be preserved by the insertion of a three-quarter bat at the angle in the stretching course: this bat is called a *king closer*. Each of them leaves a horizontal lap of two inches and a half for the next header.

In carrying up walling the whole should be brought forward as nearly as possible together, not more than four or five feet in height at a time, in order to prevent unequal bearing upon the foundations. Care should

also be taken to lay bond timber in pieces as long as circumstances will admit. Some prefer it through the centre of the wall, in which case, should there be dressings of wood-work inside the buildings, wooden plugs must be provided in the face of the wall to nail them to. When the face of the bond timber is flush with the face of the wall, these of course will be unnecessary.

It is of great importance that the mortar beds should be as thin as possible. In good sound work, four courses will not rise more than eleven inches and three quarters, and the cement should be such as will quickly set, so that the superincumbent weight may not press the joints closer, and cause settlements. Whenever there is reason for supposing, from the nature of the soil, or from the foundations being partly new and partly old, that the whole work will not come to its bearing equably, it is prudent to carry up such parts as are in this condition separately, and to leave what is called a *toothing* at the ends of those parts to be filled in when the whole has settled.

In summer time all the bricks should be wetted previous to being laid, which process causes them more immediately to unite with the mortar. But in winter the reverse of this practice should be followed to prevent the frost penetrating the work, for which reason unfinished walling should always be covered up at that period.

The thickness necessary to be given to walls is an important consideration. When the pressure on the

walls is merely vertical, less thickness will be necessary. As lateral pressure supervenes, either the thickness must be increased or some expedient adopted to counteract its effects. For instance, where walls are brought up to receive an arch, they must either be thick enough to resist the thrust by their own gravity, or be aided by piers or buttresses, or have sufficient superincumbent loading to resist the drift of such arch. A wall standing alone bears only its own burthen, the lower and upper parts mutually giving and receiving support and strength; but where arches, roofs and floors come to rest upon them, a great variety of pressure takes place, which must be duly calculated by the architect in assigning their thickness.

Let it be received as a maxim, that too much care cannot be bestowed on well fortifying all the angles, and well knitting together the return of one wall into another.

Piers or pilasters are of great assistance to strengthen a wall, the way in which they act being by increasing the base whereon the whole stands.

In carrying up the walls of buildings to any considerable height it is usual to diminish the thickness by *sets-off* as they rise. When this is the case in houses, it is customary to make these on the inside, leaving the outside upright; but where it can be effected it is better to set off equally from both faces.

In common walling a bricklayer, with the assistance of one labourer, will lay about one thousand bricks in a day; and as a rod of brickwork contains from four

thousand three hundred to four thousand five hundred bricks, he will be near four days and a half in completing such rod, whose area is two hundred and seventy-two and a quarter superficial feet, that is, sixteen and a half feet square and one brick and a half thick; but when there are many apertures in the walling, or other interruptions, he will consume a proportionably longer time in the work.

FLOORS.

THAT assemblage of timbers in the construction of buildings to which the flooring boards and laths for the plaster of the ceiling are attached, is called NAKED FLOORING. Of this there are two species, one called SINGLE and the other DOUBLE FLOORING.

SINGLE FLOORING consists of only one tier of joists in thickness (see Pl. I.* fig. 1.), in which, if a girder is used, it must not, either in this or any other case, unless circumstances render it unavoidable, be laid over any opening. If a girder be necessary, it should be laid in the middle of the apartment, or as nearly so as possible. Single floors, as compared with double ones, in which there is the same quantity of timber, are stronger; but in them the ceilings are found much more liable to crack, and present an irregular surface when finished; hence, as also when the bearing is long, it is more expedient to make use of double flooring.

In this figure (Pl. I.* fig. 1.) A A A are JOISTS, and B THE FLOORING. The laths of the ceiling are nailed to the underside of the joists. The joists, to ensure strength, should be thin and deep; perhaps their minimum of thickness, on ordinary occasions, is two inches. The following table, founded on the author's practice, may be relied upon with safety by the inexperienced, for the sizes of single joists. Fir is the timber supposed

to be used in this as in all the subsequent tables of scantlings.

Length in feet.	Width in inches.	Depth in inches.
6	2	6
8	2½	7
10	2½	7½
12	2½	8
14	2½	9
16	2½	10
18	2½	12
20	3	12

The breadths and depths above given, as those also in the tables which follow, may be varied so as to gain equal strength as circumstances may require by reference to note, pages 12 and 13, wherein the rules for such operations are laid down.

TRIMMING JOISTS may be regulated by the table hereafter given for binding joists. The joists of single flooring should not have a bearing of more than sixteen feet; when it exceeds eight, it is necessary to introduce a row of stiffening pieces to prevent their horizontal twisting; these, however, may be extremely thin, and should be placed in a line with each other between the several joists.

DOUBLE FLOORING consists of two tiers of joists, with a series of timbers called BINDERS or BINDING JOISTS, without girders in some cases, and with them in others. In the first named, the binders run from wall to wall, and the floor joists are laid thereon, and are called, as they also are when girders are used, bridging joists;

these are notched down on the upper face of the binders. The other tier consists of ceiling-joists, which are usually what is called *pulley morticed* into the binders. The arrangement will be intelligible by reference to Pl. I.* fig. 2.

A A, A A, are the binders; B B B the floor or bridging joists; D D, a pulley mortice; c c, ceiling joists, and E the flooring.

When these binding joists are framed into GIRDERS, as shewn in Pl. I.* fig. 3, the floor is properly called a DOUBLE FRAMED FLOOR, in which A is the girder; B, a binding joist; C C C, bridging joists; D D, ceiling joists; E E, the pulley-mortice, and F, the flooring boards. This sort of flooring has many advantages over single flooring in buildings of a superior class; two of which, the prevention of sound passing from one story to another, and the preservation of the ceiling, are of considerable importance.

The depths of binding joists, which should not be more than six feet apart, are not always regulated by the depth of the floor. If it be necessary that they should vary from those in the following table, they may be varied by the rules given in pages 12 and 13.

When	6	feet long they should be	6	inches deep	4	wide.
	8	. . . . .	7	. . . .	4½	. .
	10	. . . . .	8	. . . .	5	. .
	12	. . . . .	9	. . . .	5½	. .
	14	. . . . .	10	. . . .	6	. .
	16	. . . . .	11	. . . .	6½	. .
	18	. . . . .	12	. . . .	7	. .
	20	. . . . .	13	. . . .	7½	. .

The girders are the main support of a double framed floor. It is of the utmost importance that they be sound, and as free from shakes as possible. Their distance from each other should not exceed ten feet, and their scantlings may be seen in the following table.

When 10	feet long they should be	9	inches deep	7	wide.
12	. . . . .	10	. . . .	8	. .
14	. . . . .	11	. . . .	9	. .
16	. . . . .	12	. . . .	10	. .
18	. . . . .	12	. . . .	11	. .
20	. . . . .	13	. . . .	11	. .
22	. . . . .	14	. . . .	12	. .
24	. . . . .	15	. . . .	12	. .
26	. . . . .	16	. . . .	12	. .
28	. . . . .	16	. . . .	13	. .
30	. . . . .	16	. . . .	14	. .

Girders whose lengths exceed twenty-four feet, are difficult to be procured of sufficient scantling. When that is the case, or their depth would be inconveniently great, an expedient is employed, the principles of which are explained in a subsequent page, wherein those of roofs are considered, namely, that of trussing them, by which operation a beam is converted into a frame, whose purpose is to prevent any horizontal thrust being thrown upon the walls, and at the same time to suspend the girder so that it may not *sag* or bend in the middle, by means of inclined pieces butting against and within its extremities. For this purpose the girder is in two pieces, the truss is inserted in and between them, and the two pieces are then bolted together.

The securest truss for a girder is that wherein the

truss posts A (Pl. VI.* fig. 5), and abutment pieces B, are of wrought iron. The struts C may be of oak.

Bridging joists may be of the dimensions which have been given for common joists in single flooring; and ceiling joists, which should not be more than twelve inches apart, need be no thicker than is necessary for receiving the nails of the laths, for which two inches is sufficient. The subjoined table will shew their scantlings.

When	4	feet long they should be	2½	inches deep	1½	wide.
	6	. . . . .	3½	. . . .	1½	. .
	8	. . . . .	4	. . . .	2	. .
	10	. . . . .	5	. . . .	2	. .
	12	. . . . .	5½	. . . .	2½	. .

ROOFS.

Roofs are usually formed with carpentry, and covered either with tiles, slates, lead, copper, and sometimes with shingles or thin flakes of stone. Occasionally, as in the case of stone vaultings, domes, &c. the covering is merely laid on the brickwork or masonry whereof they are formed.

Roofs are almost always formed by plane surfaces, more or less inclined according to the climate of the country wherein they are erected, or to the situation of the buildings they cover: thus, in the southern parts of Europe they are kept down very low, whilst in the northern parts, on account of the rains and snow, it is necessary to pitch them higher.

A roof should be neither too heavy nor too light. Extremes must be avoided. In the one case the weight might cripple the walls; in the other it would not act as a ligature to the fabric. Whatever be its form, the whole weight should bear equally on the points of support, and particular care must be taken that its horizontal thrust against the walls be relieved or discharged. Where it can be assisted by the support of internal walls, it is desirable so to assist it. In such cases the rotting of the ends of beams does not produce those disastrous consequences which otherwise sometimes occur. The skill of an architect no where

appears more conspicuous than in the construction of a roof; and as HE is the most skilful who can produce the greatest effects from the smallest means, the student should make himself thoroughly acquainted with the principles of roofing, whereby he may save his employer much expense, and do himself no little honour. In order to this one of the most important points is, an intimate acquaintance with the exact service that each component part of a roof performs. Nothing so much tends to lessen expense, as giving strength to those parts only wherein it is necessary.

The most simple form of roof which can be used is that wherein the RAFTERS pitch upon the walls, or at least on a plate placed thereon (see Pl. II.* fig. 1). The Rafters A B, B C, rest on the walls A a, C c, and at the point of junction of the rafters at B, supposing them to be so connected as to be inseparable, but moveable as on a hinge, it is manifest that by their gravity they will have a tendency to descend, or rather their gravity gives them a tendency to spread. They will consequently push out the walls in the direction a b, c d, if the effective weight of such walls to resist the thrust in respect of their height, thickness and situation of their centres of gravity, taken as solid masses and moveable on the points X and Y, be not more than equivalent to the thrust exerted by them. Now it is known that the horizontal thrust of a roof is always proportional to the length of a line drawn at right angles from the rafter's foot, till it intersects a vertical line drawn from its apex. This perpendicular,

therefore, evidently increases as the roof grows flatter. Thus let A B and B C be the rafters, let their weights be represented by their lengths, then draw A O perpendicular thereto, intersecting the vertical in B O in O. The weight or power of thrust exerted by the rafter A B in the direction of its length, will be represented by B O, and the horizontal thrust by the line A O. Hence it is manifest that, where A B C is a right angle, we shall obtain a minimum of thrust. To obviate, therefore, the danger arising from these thrusts, means must be employed to confine the feet of the rafters; and for this purpose a beam, A C (Pl. II.* fig. 2), is introduced across the opening, and made fast to them. This is called a TIE-BEAM, and is pulled or exerts its power for the above purpose in the direction of its length. If a tie is introduced above the level of the walls, as a c, it is called a COLLAR. For this object, as the strain is lengthwise, or in the direction of the fibres of the timber, a small size or SCANTLING will be sufficient, provided means be employed for preventing its bending with its own weight, or, as the workmen term it, sagging. This leads to another expedient, namely, the introduction of a fresh tie called a KING-POST, D B (see Pl. III*. fig. 1), which slings or ties up the beam to the apex of the rafters. The whole combination now receives the name of a TRUSS. If the rafters are of such length as to be in danger of sagging or bending, they must be furnished with supports, a a, called STRUTS, in a direction as nearly perpendicular to the rafters as the form of the roof will admit.

From those points of the struts whereat they can be secured to the rafters, it is clear that a new system of trusses may be projected (see Pl. III.* fig. 2). So that in theory there is no extent over which a roof may not be thrown. But in practice we find that the compressibility of the fibres of the timber in lines at right angles to their directions is very great, and in metal its contraction and expansion are to be dreaded: thus limits are soon assigned, beyond which, in practice, it would be hazardous to proceed. The squeezing or compressibility of the fibres of timber requires much attention. It may be laid down as a rule in all pieces of carpentry, that the more the weights or pressures are brought to act in the same direction as the fibres of the timber, the less will be the quantity of compression. Let us examine the compression which takes place on the head of a king-post (see Pl. III.* fig. 3). Here the rafters butt against the shoulders A B, C D, the fibres of the wood being vertical, a compression takes place, by which the rafters may approach each other. The king-post and tie-beam which it supports consequently drop, and the whole combination or truss is injured by it. To remedy this inconvenience oak has been introduced, whose incompressibility is much greater than fir; and this should be introduced in all roofs of great extent; but the substitution of cast iron king-posts is an improvement of the utmost importance where the expense can be afforded. A cheap mode of gaining the same end is shewn in the above diagram, wherein the rafters are *housed* in the head of the king-

post, which has a housing or large hole cut through it in the form and at the angles at which the rafters meet. Thus the fibres of the rafters butt against each other in a much better way, and the beam is then literally suspended from the vertical planes of the rafters at their junction.

We now come to another sort of roof, but as it is constructed on the same principles as the former, little more than inspection of Pl. III.* fig. 4, will be necessary. Here the posts A B, C D are called QUEEN-POSTS, and the piece D B a COLLAR. In this roof the beam has three points of support, namely, B, E, and D. It should be noticed that the collar B D in this case is more properly called a STRAINING-PIECE, and performs an office the reverse of that noticed in the second diagram.

The MANSARD (Pl. IV.* fig. 1), from the name of its inventor, or CURB ROOF is in common use; it may first be considered as consisting of four pieces of timber, moveable as on hinges at the points A B C D E. If these be inverted as the dotted lines shew, they will arrange themselves in such angles that returned to their first position they will equilibrate; but in practice we know the equilibrium thus found to be tottering. It must, therefore, be secured first, so as to prevent the whole assemblage thrusting out the walls, and in the next place so as to prevent the upper from thrusting out the under rafters. For the first purpose the tie A E is introduced as in the figure (Pl. II.* fig. 3); for the other the tie B D is necessary. The assemblage is

then completed, and if the extent renders it necessary, the tie-beams and rafters must be prevented from bending, by the means shewn in Pl. II.* fig. 2 and 3.

Having so far explained the elementary principles on which the principal parts of a roof are put together, it is now to be observed, that as trussing every pair of rafters would be extremely expensive, and not less inconvenient in practice, the method universally adopted is to place the trusses, only, at certain intervals, not however exceeding ten feet apart. The rafters so trussed, are called principal rafters, and on them the common or smaller rafters bear, through the medium of a horizontal timber called a PURLINE, marked A in Pl. IV.* fig. 2, upon which they immediately rest, the purline being made fast to the back of the principal rafter, and the common rafters notched down thereon. They are received on a POLE-PLATE, B, at their feet, and by the RIDGE D, above. Along the wall lies a piece of timber called a WALL-PLATE, C, on which the tie-beams lie.

If the roof slope each way (see Pl. IV.* fig. 3), the space included by the intersection of the slopes, is termed a HIP, and the longest or rafters at the angles, HIP-RAFTERS; each rafter which is shorter than the side rafters is called a JACK-RAFTER.

In bolting the timbers of a roof together, the direction of the thrusts or strains which the pieces exert or suffer should be well considered, and the bolts or fastenings placed so that they may pull as nearly as possible in opposite rectilineal directions.

The following list of scantlings for roofs, which are the result of much application to the subject and long experience, may be trusted to, if the work be executed by competent artificers; they will be found, it is apprehended, a medium between the overloading of ignorance and the fanciful doctrines exhibited in the works of mere theorists. The trusses should, on no account, be placed at a greater distance than ten feet from each other; and are arranged under three heads.

1. For spans from twenty to thirty feet, a truss with a king-post and struts only will be necessary (see Pl. III.* fig. 1, and Pl. IV.* fig. 2).

2. For spans from thirty to forty-five feet, a truss with two queen-posts and struts will be required, with a straining piece between the queen-posts.

3. For spans from forty-five to sixty feet, a truss will be required with two queen-posts, a straining piece between them, struts from the queen-posts to the small queen-posts, and struts again from the latter.

FIRST HEAD.

Span in feet.	Tie-beams.	King post.	Principals.	Struts.
20	9 by 4	4 by 4	4 by 4	4 by 3
25	10 . . 5	5 . . 5	5 . . 4	5 . . 3
30	11 . . 6	6 . . 6	6 . . 4	6 . . 3

SECOND HEAD.

Span in feet.	Tie-beams.	Queen posts.	Principals.	Straining piece.	Struts.
35	11 by 4	4 by 4	5 by 4	7 by 4	4 by 2
40	12 . . 5	5 . . 5	5 . . 5	7 . . 5	5 . . 2½
45	13 . . 6	6 . . 6	6 . . 5	7 . . 6	5 . . 3

THIRD HEAD.

Span in ft.	Tie-beams.	Queen posts.	Small queen ps.	Principals.	Straining piece.	Struts.
50	13 by 8	8 by 8	8 by 4	8 by 6	9 by 6	5 by 3
55	14	9	9	8	9	4	8	7	10	6	5½	3
60	15	10	10	8	10	4	8	8	11	6	6	3

The scantlings for purlines are subjoined.

Bearing in feet.	Scantlings.
6	6 by 4
8	7 . . 5
10	8 . . 6
12	9 . . 7

The scantlings for common rafters are as follow.

Bearing in feet.	Scantlings.
8	4 by 2½
10	5 . . 2½
12	6 . . 2½

As the student advances in knowledge he will, by the contemplation of roofs that have been executed, be led to employ many expedients and modifications of the forms here given, as circumstances may require the exercise of his talents and ingenuity. Enough has been advanced for an elementary treatise.

When the length of a beam is so great that it is inconveniently procured in one length, it becomes necessary to make it of two pieces, and indent the joint of them, making the two pieces one, by means of bolts. This is termed scarfing, and is extremely useful in practice. The diagram (Pl. V.* fig. 1) shews the method of doing this in four different ways: A and B are good joints for plates, lintels or ties. If a beam is

to be scarfed, it will be necessary to add the bolts shewn in the figures. When additional strength is required, C or D may be adopted; the latter is accomplished without loss of length in the pieces of timber. The length of the joints may be increased; all that is here proposed being to shew the mode in which the pieces are joined.

THE EQUILIBRIUM OF ARCHES.

VARIOUS theories have been invented in order to discover, from mathematical principles, a mode of constructing an arch whose parts may be all in equilibrio, the most ingenious of which is undoubtedly that which establishes the law of the equilibrium upon the principle of the inverted catenaria; but as the calculation necessary to determine that law requires a knowledge of the higher branches of the mathematics, which do not always form a part of the education of the practical architect, it follows that, in the exercise of this branch of his profession, he is obliged to take upon trust the rules which have been previously deduced by the speculative mathematician.

As, however, it is always satisfactory to the mind to be convinced of the truth of the rules which direct its operations, an essential service may be rendered to many professional men as well as students, in adopting a theory from which the requisite practical rules may be easily deduced, and the development of which is within the comprehension of persons but slightly acquainted with the science of mechanics.

The voussoirs or arch-stones are considered as having a determinate length, and acting as so many wedges endeavouring to split the arch by the tendency which they all have by their gravity to fall inwards, that is, towards the centre of the arch.

If a sufficient number of experiments had been made on the actual force of the wedge in splitting bodies, or rather, if experiments had been made upon the descent of bodies down planes variously inclined to the horizon, we might have been able so to have modified the principle assumed, as to have produced a construction which probably would have coincided accurately with the best examples which practice has shewn; but for want of such experiments, we must content ourselves with an approximation as near to the truth as existing circumstances allow.

Let A B C D, &c. (Pl. VI.* fig. 1.) be the interior curve or intrados of any arch whatever, formed by the voussoirs A B, B C, C D, &c. each of these voussoirs is held in its place by the pressure of those adjoining it, and each, except the two lowest voussoirs, A B, and L M, tends to slide upon the inclined plane formed by the contiguous side of the next lower voussoir; if, therefore, the magnitudes of all the voussoirs were such, that, including the resistance caused by their mutual friction, they all tended with equal forces towards the centre of the curve, then the arch would be in equilibrio in all its parts. To obtain this, we must first determine what the magnitude of the voussoirs should be, to constitute an equilibrated arch, supposing their joints to be perfectly smooth and slippery, and consequently that the stones tend inwards by the force of gravity without being at all retarded by friction: afterwards it will be shewn how to counteract the resisting force arising from this cause.

It is a well known proposition in mechanics, that, when a heavy body is placed upon an inclined plane, the force which would prevent it from sliding down, or, which is the same thing, the force with which it slides down, is to the whole weight of the body, as the sine of the plane's inclination to the horizon is to its length; thus, let A B (Pl. VI.* fig. 2) represent the length and direction of the plane, and A C the horizon, then the force with which a body would slide down the plane is to its weight as B C is to A B; the pressure also which the same body exerts against A B, in a direction perpendicular thereto, is as A C.

Now in an arch the voussoirs themselves are the bodies which slide down the inclined planes of the subjacent voussoirs, and it is required to determine their magnitudes, so that they may all tend to slide towards the centre of the curve with equal forces; if, therefore, the breadths of the voussoirs be supposed indefinitely narrow, as in Pl. VI.* fig. 2. their magnitudes will be proportional to their lengths, and to determine those lengths, we shall have to make the vertical lines a b, c d, c′ d′, &c., representing the forces with which the voussoirs tend inwards equal to each other; then to draw c e, c′ e′, &c. perpendicular to the curve of the intrados, and indefinite in length, and lastly to draw d e, d′ e′, &c. perpendicular to c d, c′ d′, &c.; the lines c e, c′ e′, &c. will be the length of the voussoirs, required; and d e, d′ e′, &c. will represent their pressures upon the next subjacent voussoirs; lastly, if a curve line be drawn through all the points b, e, e′, &c. it will

be the extrados of the voussoirs. It must be noted that, though we here suppose the arch-stones to be extremely narrow, yet when they are made wider, the extrados will not differ sensibly from that which is obtained by this method, because each large voussoir may be supposed to be made up of a number of smaller ones, therefore the whole effect of the great voussoir will be the same as that of as many small ones as are equal to it.

It may seem, that when the arch-stones have got to their proper bearing, before the centering is removed, they cannot afterwards move; but this is a mistake, for on account of their friction at the beds of the arch, and the lateral pressure they experience from all the superior voussoirs, they do not press inward with equal forces, as the foregoing rule would imply, those which present the greatest surfaces to each other and which receive the greatest lateral pressure experiencing most resistance to their tendency downwards, which should be corrected by a weight placed over them proportional to such resistance. It is sufficiently proved by experiments, that a larger surface causes more friction than a smaller; and if we take the quantity of friction to be proportional to the surfaces in contact, it would follow that to counteract the effect of friction in this case, the voussoirs should be loaded vertically with weights respectively proportional to their surfaces multiplied into their lengths, because the effective force of any weight upon the arch depends upon the plane in which it acts; but as the voussoirs are all supposed

to be of equal depths, that is perpendicularly to the face of the arch, their surfaces will be proportional to their lengths, therefore each voussoir should be loaded with a weight proportional to the square of its length.

But the friction of the voussoirs is augmented by the lateral pressure which each experiences from those above it, and even from the weight of part of the loading about the crown of the arch, both of which operate to diminish the tendency which the lower voussoirs should have to fall inwards; and when the lateral pressure becomes greater than the force with which the voussoirs tend inwards, it not only destroys that tendency, but acts as a force impelling them outwards. We are, however, without sufficient data to enable us to make an exact allowance on these accounts, for the quantity of friction of bodies is not exactly proportional to their mutual pressures, but seems to follow a less ratio. An attempt to pursue this subject with the utmost correctness, would lead us into an investigation too complicated for this work; we must therefore be satisfied with having pointed it out as one of the causes which will operate to hinder the exact conformity of the theory with practice, and shall merely correct the friction arising from the lateral pressure of the voussoirs by loading them with weights proportional to the lines e d, e′ d′, which, as above stated, represent those pressures.

Hence on the two accounts above-mentioned, the vertical height of the loading over the arch-stones must be proportional to the square of e c, multiplied by d e,

to produce the required equilibrium, and agreeably to this rule the lines e f, e′ f′, &c. were determined; but it must be observed that the heights of e f, e′ f′, &c. should be at least equal to the lines d e, d′ e′, &c. because no weight over the arch-stone less than the actual pressure it experiences from that above it, can counteract the effect of that pressure. In order to obtain this it is only necessary that the vertical heights of the loading be taken from such a scale as shall make them greater than e d, e′ d′, &c. and if this is done for one height, the same scale will serve for all the others.

If the line of the top of the arch b f f′, &c. form a convenient roadway, as in the case of a bridge, the arch is completed, or if a small variation only should be necessary, it may be made without sensibly affecting the stability of the work; but should the roadway require a much greater quantity of matter to be placed over the haunches of the arch, in order to raise it to a proper height, than this construction allows, it will perhaps become necessary to lighten the spandrels by perforating them in one or more places, as at N and O, Pl. VI.* fig. 1.

The height of the loading over those parts of the arch which are adjacent to the springing course, is much greater than can in reality be given: but this excessive height will not appear necessary, if we consider that the masonry which is laid over the arch is bonded with that of the pier or abutment, so that to a certain extent over the haunches of the arch the

loading may be considered as forming part of the pier, and consequently as not capable of being broken up by the gravity of those parts of the arch about the vertex. It presents a resistance to such a fracture which may be considered as infinite, and therefore equivalent to the weight of loading which the theory requires.

The length of the voussoirs at any part of the arch, as well as the lines d e, d′ e′, representing their mutual pressures, may be calculated trigonometrically, according to the measure assumed for the height of the crown voussoir, and from thence the lengths of the vertical lines over the voussoirs, may be determined by the rule above laid down.

It has been objected to all the theories of the equilibrium of arches, that some examples which are constructed in a manner widely different from them will yet stand firmly. To this it may be answered, that if the friction and cement of the joints are equal, or nearly so, to the cohesive power of the stone, the arch will stand as well as one of the same size, cut out of a solid rock, to which no arch, however accurately balanced, can be superior in strength. Hence, in arches of small span, where the voussoirs bear a considerable proportion to the size of the whole arch, the power of friction is great, and it is less necessary to attend to the theory; but in large arches the case is far different.

PIERS.

In order to determine the magnitude of the piers or abutments, that they may sustain an arch in equilibrio, it is usual to consider the pier as extending over the arch as far as a certain point called the joint of fracture, which point is found by drawing a line from the middle of the key voussoir at a, (see Pl. VI.* fig. 3,) touching the intrados of the arch and reaching to the middle of another voussoir as at b. This point b is considered as the place where a fracture would probably happen in the arch by the superior gravity of the voussoirs above it. Through b draw F b s perpendicular to the curve, then may F D E S represent the half arch, tending by its lateral thrust to overturn the pier F P Q S upon the point Q, or to make it slide horizontally along the line P Q.

Find g the centre of gravity of the half arch, which may be done mechanically thus. Cut out in pasteboard the figure of the half arch, and hang it up by a point as F, then a plumb line hung also from F will mark a line upon the pasteboard which passes through the centre of gravity. Again: hang the pasteboard up by another point as E, and suspend a plumb line from the same point, this line will cut the former from F in g, the place of the centre of gravity. Assume at pleasure

any breadth as P Q for the intended pier, and by the foregoing method find the place of the centre of gravity of the pier which suppose to be at G, and draw G H perpendicular to P Q. Let the area of the half arch be represented by A′, and that of the pier by P′, and suppose the specific gravity of the materials of the arch and pier to be the same, then A′ and P′ will represent the weight of the arch and pier respectively.

Now the force with which A′ presses upon E S may be thus found: through g draw the vertical g f, draw g o perpendicular to F S, and through o draw the horizontal line o f, then if the semi-arch be confined between the planes E D and F S, g f will represent the weight of A′, or its pressure in the vertical direction, f o its pressure horizontally, and g o its pressure upon F S perpendicularly.

Therefore A′ : its pressure on F S :: g f : g o that is :: sin. ∠ g o f : sin. ∠ g f o. Produce g o to I; then since ∠ g o f = ∠ g I P, and the ∠ g f o is a right angle, A′ : pressure on F S :: sin. ∠ g I P : Radius (=1).

Therefore A′ × 1 = sin. ∠ g I P × pressure on F S, and the pressure on F S (in the direction g o) $= \frac{A'}{\text{sin. } \angle g\, I\, P.}$

In the same manner, it may be found that the pressure of the half arch on F S in the direction of f o is equal to $A' \times \frac{\text{cosine } \angle g\, I\, P.}{\text{sin. } \angle g\, I\, P.}$

When the pressure of the half arch is taken in the direction g I, while the weight of the piers opposing that pressure acts in G H, then in order to obtain an

equilibrium, and to prevent the pier from being overturned upon Q, we must suppose Q to be the fulcrum, and all the matter of the pier to be accumulated in H, acting vertically at the end H of the arm of the lever H Q, while the pressure of the arch on F S acts at k in the direction g I, at the end of the arm k Q, of the lever H Q k, or, which is the same thing, it may be supposed to act at h in the same direction at the end of the arm h Q of the lever H Q h, hence by the nature of the lever $\frac{A'}{\text{sin. } \angle g\, I\, P.} \times Q\,h = P' \times Q\,H$; consequently $\frac{A'}{P} = \frac{Q\,H}{Q\,h} \times \text{sin. } \angle g\, I\, P.$ And that the pier may resist effectually the thrust of the arch to overturn it, the value of Q P and consequently those of Q H and Q h must be altered till the two sides of this equation can be made equal to each other.

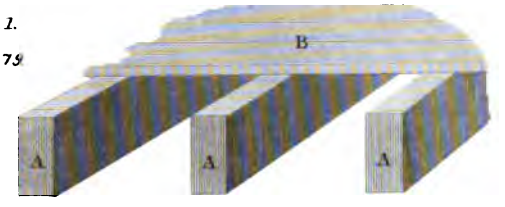
But when we would prevent the pier from sliding along P Q, we must make it of such magnitude, that its horizontal resistance may be equal to the pressure of the arch in the direction f o, that is, equal to $A' \times \frac{\text{cos. } \angle g\, I\, P.}{\text{sin. } \angle g\, I\, P.}$ Now by some experiments the quantity of friction of a body moving along a horizontal plane is found to be about one fourth of the weight of the body; therefore, to make the pier capable of resisting the pressure of the arch we must assume $\frac{P'}{4} = A' \times \frac{\text{cos. } \angle g\, I\, P}{\text{sin. } \angle g\, I\, P}$ which gives $\frac{P'}{4\,A'} = \frac{\text{cos. } \angle g\, I\, P}{\text{sin. } \angle g\, I\, P}$; or $\frac{4\,A'}{P'} = \frac{\text{sin. } \angle g\, I\, P}{\text{cos. } \angle g\, I\, P}$;

and since the sine of any angle divided by its cosine is equal to the tangent of that angle, (by Trigon.) we have $\frac{4\,A'}{P'} = \text{tang.} \angle g\,I\,P.$

In this last expression all the quantities may be obtained from the construction except P′, which therefore may be found by reducing that equation, consequently if the height of the pier be assumed, its breadth may be determined.

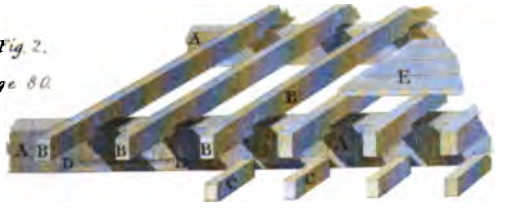
SINGLE FLOORING.

Fig. 1.
Page 79



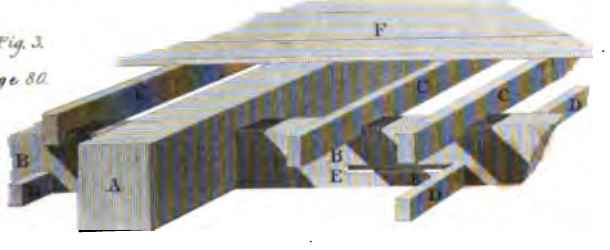
DOUBLE FLOORING.

Fig. 2.
Page 80.



DOUBLE FRAMED FLOOR.

Fig. 3.
Page 80.



J. C. del.

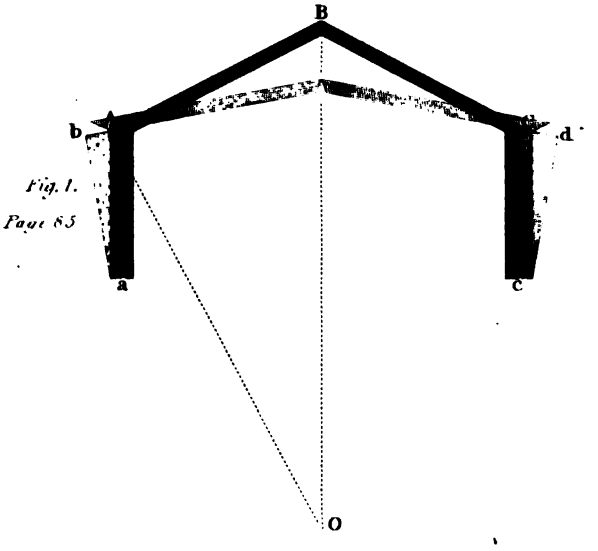


Fig. 1.
Page 85

CONSTRUCTION OF ROOFS.

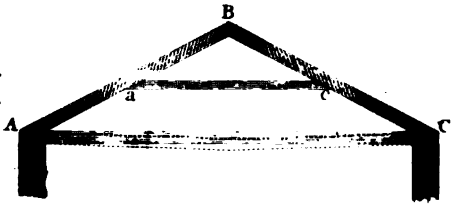


Fig. 2.
Page 86

Fig. 3.
Page 89

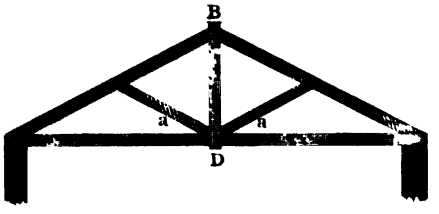


Fig. 1.
Page 86 90

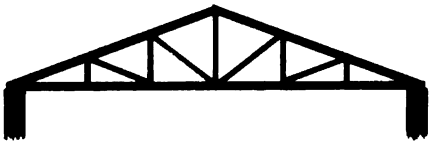


Fig. 2.
Page 87

CONSTRUCTION OF ROOFS.

Fig. 3.
Page 87

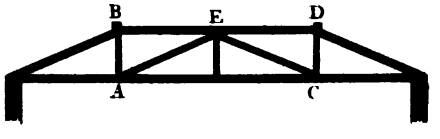


Fig. 4.
Page 88

* Plate

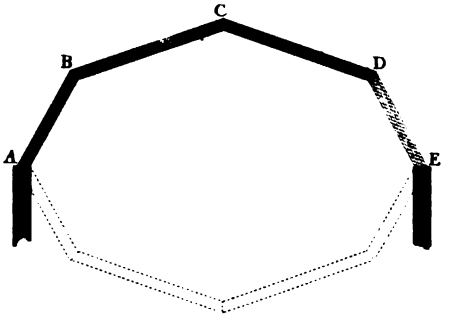


Fig. 1.
Page 88.

CONSTRUCTION OF ROOFS.

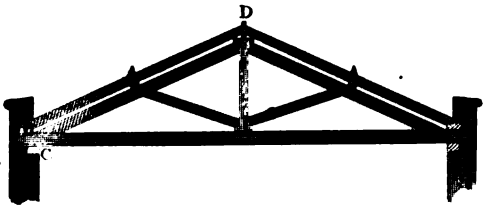


Fig. 2.
Page 89. 90.

Fig. 3.
Page 89.

J. C. del.

SCARFING

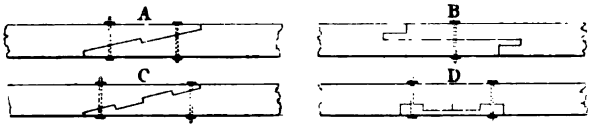


Fig. 1.
Page 91.

CONSTRUCTION OF VAULTING

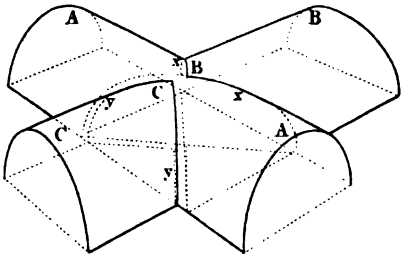


Fig. 2.
Page 140.

CONSTRUCTION OF DOMES

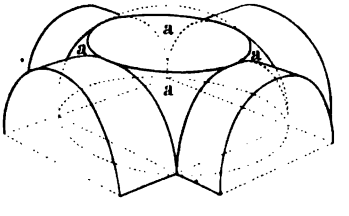


Fig. 3.
Page 140.

J. & A. H.

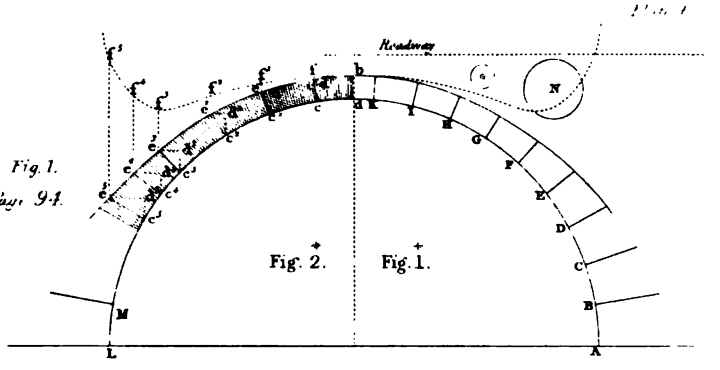


Fig. 1.
Page 94.

CONSTRUCTION OF ARCHES, AND PIERS.

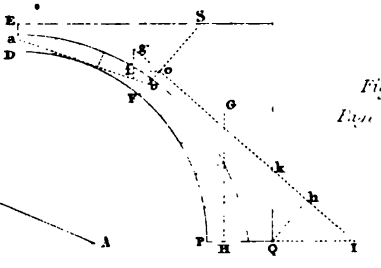


Fig. 3.

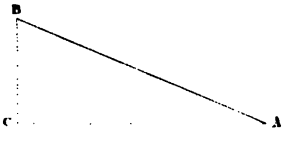


Fig. 2.
Page 95.

TRUSS FOR A GIRDER.

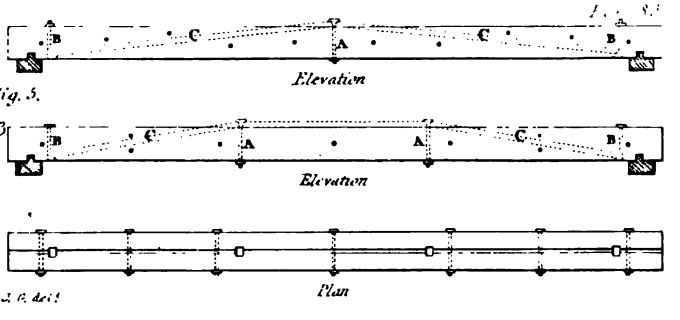
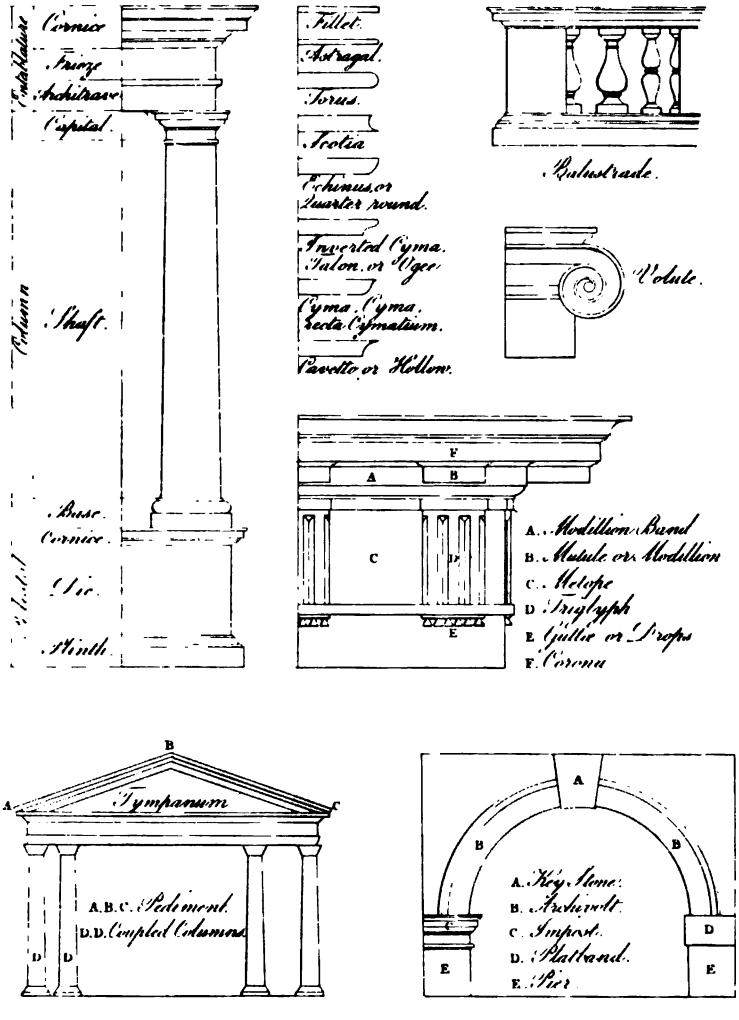


Fig. 5.
Page 83.

PARTS OF AN ORDER



SECTION III.

OF THE

ORDERS, AND THEIR PARTS, ETC.

PARTS WHICH COMPOSE AN ORDER.

THE parts of which an order is composed are properly divided into those which are essential, and those which are subservient. The essential parts are the column and the entablature, see Plate I.; the subservient are the mouldings and detail into which the column and its entablature are subdivided. We will first describe the latter.

There are eight sorts of regular mouldings, viz. the ovolo, the talon, the cyma, the cavetto, the torus, the astragal, the scotia, and the fillet. These mouldings are not to be used at hazard, each having certain situations adapted to its reception, to which it must always be applied. Thus the ovolo and talon, from their peculiar form, seem intended to support other important mouldings or members; the cyma and cavetto being of weaker contour, should only be used for the cover or shelter of other parts; the torus and astragal bearing a

resemblance to a rope, appear calculated to bind and fortify the parts to which they are applied; the use of the fillet and scotia is to separate one moulding from another, and to give a variety to the general profile. The ovolo and talon are mostly placed in situations above the level of the eye; when below it, they should only be applied as crowning members. The place for the scotia is universally below the level of the eye. When the fillet is very wide, and used under the cyma of a cornice, it is termed a corona; if under a corona, it is called a band.

The curved contours of mouldings are portions of either circles or ellipses, and it may be here observed that the Greeks ever preferred the latter, or some other conic sections for the profiles of their mouldings.

PROFILE OF AN ORDER.

THE PROFILE of an order, Plate I. is an assemblage and arrangement of essential and subservient parts. That is preferable wherein the parts are few, varied, and fitly applied. Some member should predominate in each division, which it should appear the business of the other parts to fortify, support, or shelter. In a cornice, for instance, the corona is supported by modillions, dentils, ovolos, and the like, and sheltered and covered from the effects of the weather by its cyma or cavetto.

Mouldings, see Plate I. may be ornamented, but ornaments must be employed neither too frugally, nor scattered with too much profusion. Their leading forms should fall perpendicularly under each other, and the smaller parts should be regulated by the larger. All ornaments in the entablature should be governed by the modillions; the modillions are themselves also dependent on the intervals between the columns. The ornaments of mouldings should be cut into the solid, and not applied on the surface. The external angles should never be cut; they are usually decorated with a leaf.

An order is divided into two parts, namely, the column and entablature. The column is subdivided into three unequal parts, viz. the base, the shaft, and

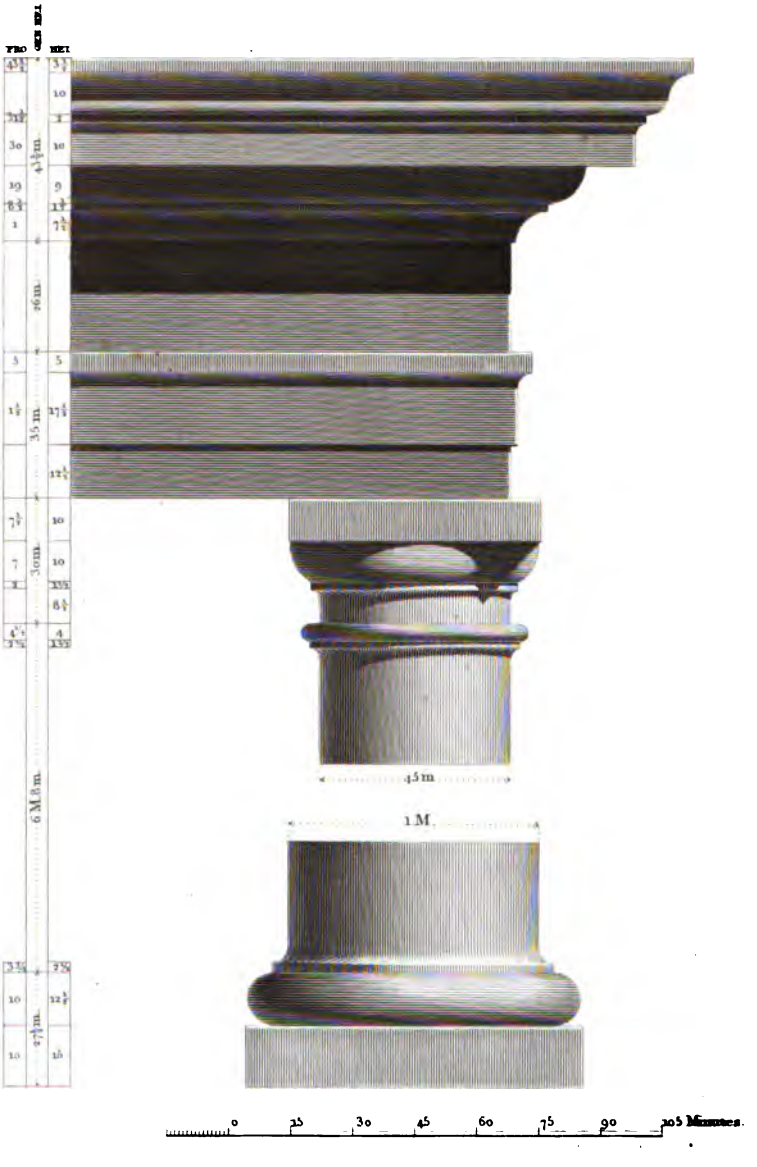
the capital. The entablature consists also of three unequal parts, which are the architrave, the frieze, and the cornice. Each of these divisions is composed of several smaller parts, which, by their variety and peculiarity, distinguish the orders from each other.

The method of drawing or profiling an order is by means of a scale of equal parts formed on the lower diameter of the column. The diameter of the column in all the orders is divided into sixty parts, each of which is called a minute, and the figures on the profiles of each of the orders in the plates attached to the work, are in those terms, and in that of the whole diameter, which is called a module.

In the Doric order alone the semi-diameter bears the name of a module, and consists, according to the above division, of thirty minutes, but in all the other orders as just before-mentioned, the word module is usually intended to express the measure of the whole of the lower diameter of the shaft of the column.

PLATE II

TUSCAN ORDER AFTER PALLADIO.



Jos Gwilt

W. Kelsall sc

THE FIVE ORDERS.

THE TUSCAN ORDER,

THE simplest of the orders of architecture, usually occupies the first place in the description of them; but whatever its claims in point of antiquity, which are indeed not borne out by ancient examples, its extreme simplicity seems to urge the earliest notice.

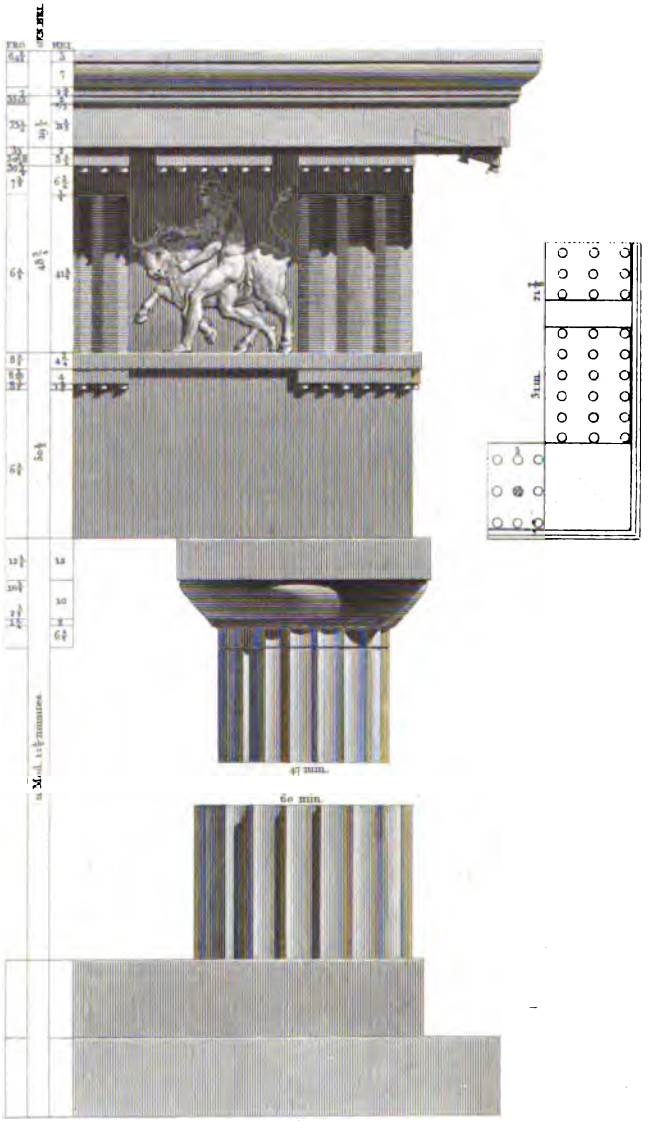
The Tuscan is in reality nothing more than a rude Doric, without the finish and elegance of that improved order, and in point of priority it is quite reasonable to suppose that some such forms as those in which this order appears should have preceded the elegant Doric of the Greeks, even of the earliest examples of it.

It has strength and a grace even in its rudeness, and certainly possesses more of the appearance of an original than the Doric. Its main object seems utility, for it is destitute of all ornament. It is the most easily executed, and when employed with judgment, has not only grace, but by contrast gives a beauty to the other orders.

Vitruvius speaks of this order as rustic even to deformity, but Palladio, who was more of an artist, is not inclined to think so lightly of its merits and utility.

The example which is given of this order, Plate II. is after Palladio. The most perfect profile of it in this country, is at the church of St. Paul, Covent Garden, by Inigo Jones; but as there used it is not suitable to every application of the order, though in that instance, from various circumstances, it is a remarkable proof of the architect's judgment, showing what charms may be produced by a good choice of proportions, and that harmony is not the result of a profusion of ornament or affected rusticities.

DORIC ORDER AT ATHENS.



Scale of 12 6 0 1 2 3 4 5 6 Feet.

THE DORIC ORDER,

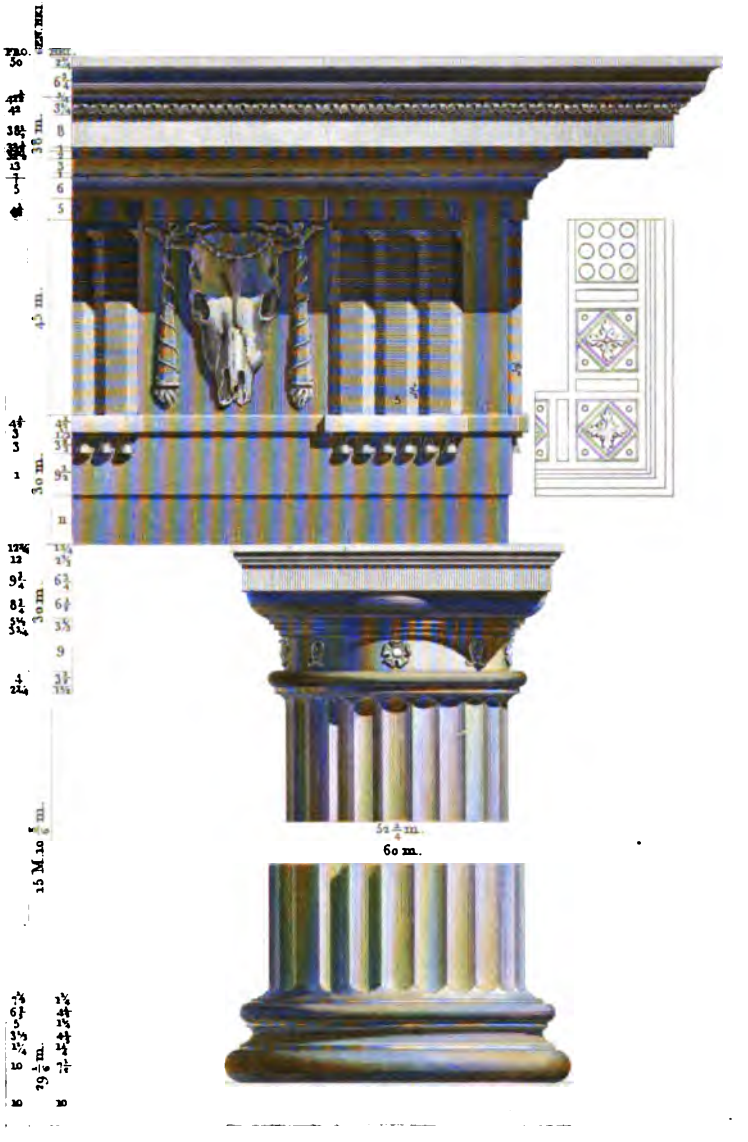
WHOSE true origin and birth-place has not been satisfactorily ascertained, inasmuch as the uncorroborated assertions of Vitruvius on this subject cannot be relied on, may have been the earliest that was invented. In the Greek examples the proportions vary considerably; in them, however, the column is without a base, which is usually found in the Roman Doric. The Greek Doric column stands on the floor or pavement of the building without socle, tori, or fillets; it presents a more pyramidal appearance than the other orders from its considerable diminution. Its flutes are wide, and not deeply sunk. The capital has no astragal, but generally only some small annulets which divide it from the shaft. The ovolo is very flat, of large projection, and returns into the abacus suddenly. The entablature is divided so that the architrave and frieze are each more than a third of its height, the remainder being given to the cornice. The triglyphs are of much less projection, and their channels less sunk than in the Roman examples, one always being placed on the external angle of the frieze. The metopæ between the triglyphs are nearly square, and mutuli are placed over them as well as over the triglyphs themselves. The cornice consists of a band under the mutulus, then the mutulus projected forward under the corona, over

which is usually an ovolo and fillet, with another larger ovolo and fillet thereover. The column is five or six diameters high. The principal examples of Grecian Doric extant are, in the Parthenôn, Temple of Theseus, Propylæa, and Portico of the Agora of Athens, Temple of Minerva at Sunium, a temple at Corinth, Temple of Jupiter Nemæus between Argos and Corinth, the Temple of Apollo, and the Portico of Philip in the Isle of Delos, Temple of Jupiter Panhellenius at Ægina, Temple of Apollo Epicurius at Phigalia, two temples at Selinuns, the Temples of Juno Lucina and Concord at Agrigentum, a temple at Ægesta, and the three temples at Pæstum. Those however of the Parthenôn and Theseus at Athens, and of Minerva at Sunium, are the most elegant examples. The example, Plate III. of this order is from the Temple of Theseus at Athens.

The Roman Doric varies much from that just described; in it the triglyphs are always over the centre of the columns, and the metopæ are, or ought to be, exactly square. Hence the intercolumniations are regulated by the triglyphs. It is sometimes placed on a plinth, at other times on a pedestal with a few plain mouldings. Its base is occasionally Attic, and at other times with only a torus and astragal. The capital has a neck and astragal under the ovolo, and a small cyma reversa and fillet on the abacus. Of this order the only pure ancient example is in the Theatre of Marcellus at Rome. The flutes in both are twenty in number. The example, Plate IV., of this order, is the modified Roman or rather Italian of Palladio.

PLATE IV.

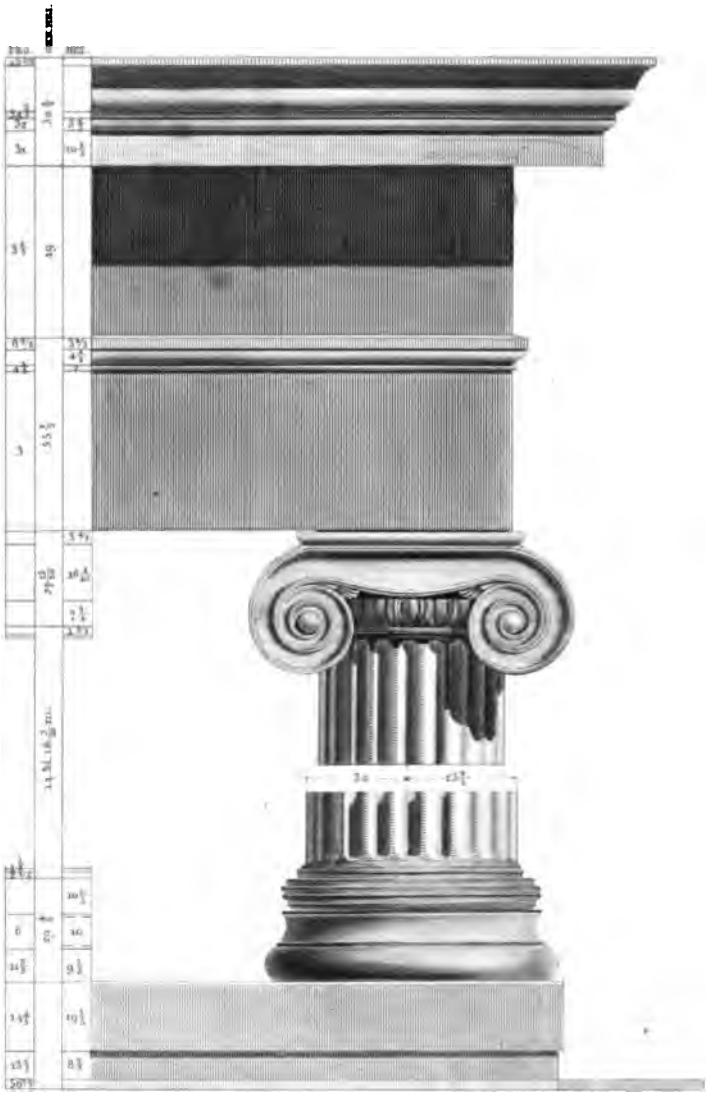
DORIC ORDER AFTER PALLADIO.



Scale of 0 5 15 30 60 90 120 Minutes.

Jas. Carter sc

IONIC ORDER AT ATHENS.



Scale of 0 10 20 30 40 50 60 120 Minutes

J. Lewis

J. Baillie sc

THE IONIC ORDER.

Of the origin of this order as little can be said as of the preceding. Vitruvius, as before, is its only historian, and his tale is too absurd for notice. Its distinguishing features are the volutes of its capital. In this order there is much difference between the Grecian and Roman examples: in the former the volutes appeared only in front and rear, between which the other sides were in a baluster-like form, but at the external angles of the capitals of the corner columns a diagonal volute was introduced. The Romans gave their capitals four diagonal volutes, and hollowed out the sides of the abacus. In the Greek volute the fillet of the spiral is continued along the face of the abacus, in the Roman it rises from behind the ovolo. In some of the Athenian specimens, there is a neck below the echinus with flowers and plants sculptured thereon. The column is usually about nine diameters high, and its pedestal in modern application, higher and more ornamented than the Doric pedestal. The base is very different in the several examples.

The entablatures of the early Ionic are usually very simple. The architrave has one or two fasciæ. The frieze is plain, and the cornice with few parts. In the more modern Ionics, the architrave has generally two fasciæ, the cornice is deeper, its profile more varied,

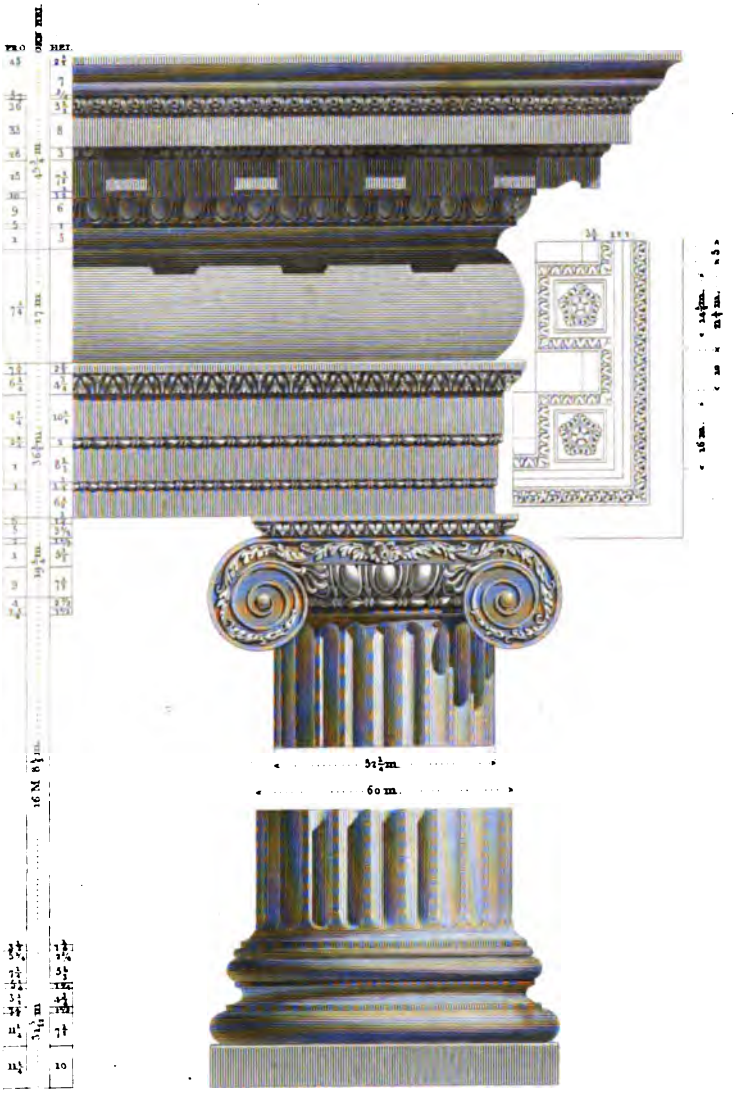
and sometimes decorated with modillions, these however are to be reckoned rather as a modern introduction, the dentil being the more antique ornament for the bed-mould.. The shaft of the column has, when fluted, twenty-four flutes, which are semi-circular or semi-elliptical and separated by fillets.

The ancient examples of the Ionic order are, in the temple on the Ilissus, a profile of which is given in Plate V., of Minerva Polias, of Erechtheus, and that at the Aqueduct of Hadrian at Athens, the Temple of Minerva Polias at Priene, of Bacchus at Teos, of Apollo Didymæus at Miletus, and of Fortuna Virilis and in the Coliseum at Rome. The Temple of Concord at Rome is so corrupt a specimen that it never ought to be followed nor used.

The pedestal of this order is higher, and contains more members than that of the Doric.

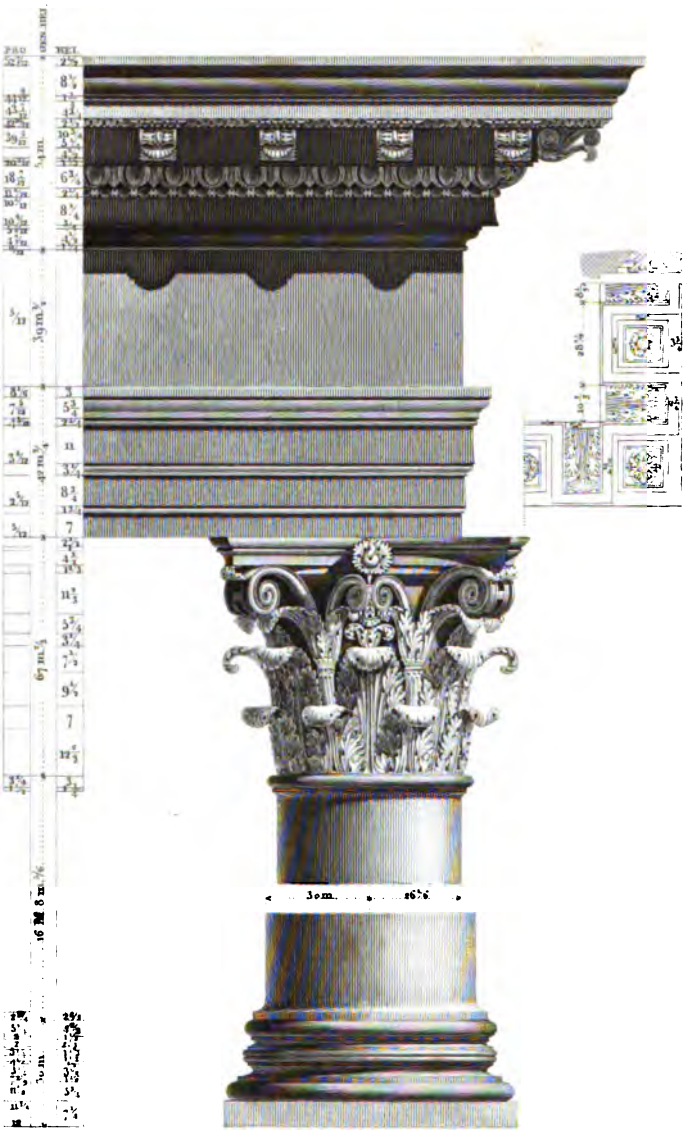
The profile of the Ionic in Plate VI. is after Palladio.

IONIC ORDER AFTER PALLADIO.



Scale of 0 5 10 15 30 45 60 75 90 Minutes.

CORINTHIAN ORDER AT ROME.



Scale of 0 5 15 30 60 90 120 Minutes.

THE CORINTHIAN ORDER

Is more distinguished from the Ionic by its capital than by its other parts, and admits of the highest degree of enrichment. This order has at once an air of dignity and beauty; it strikes and commands the attention, and cannot be viewed without pleasure as well as admiration. The capital is a vase covered with an elegant abacus, and encompassed by two tiers of leaves, one above the other; from among these leaves rise stalks which terminate at their summits in small volutes at the external angles and centres of the abacus. In this order the abacus is a decorated part, it differs also from the others in having no ovolo. The other capitals are added as it were to the tops of the shafts, but this seems to grow out of the column. The height of the capital varies from a diameter and one sixth of the lower part of the shaft, to one diameter only, which is that of the capital of the Temple of the Sibyl at Tivoli. The entablature of this order is variously decorated. It much resembles the latter Ionic in its form and composition, but with many more ornaments. Its architrave has usually three fasciæ of unequal height; in the Frontispiece of Nero, and the Basilica of Antonine, however, there are only two. The frieze is frequently decorated with foliage. The cornice is ornamented with both modillions and dentils: the former have a

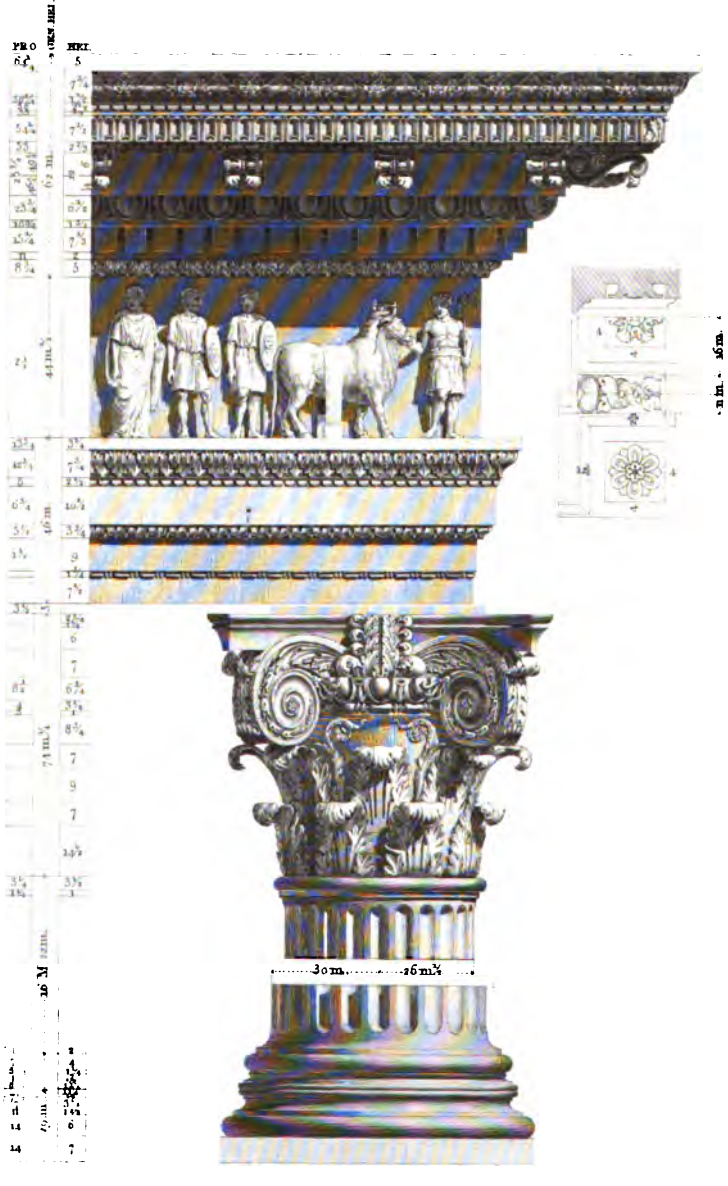
baluster front with a leaf under them, the dentils, which are cut on the surface of the band, are occasionally omitted. The modillions are also sometimes omitted in this order.

The remaining examples of this order are a Portico and the arch of Hadrian at Athens, a Temple near Mylassa, and the Incantata, as it is usually called, at Salonica.

The following are at Rome: Temple of Mars Ultor, Portico of Severus, Forum of Nerva, the Temple of Vesta, Basilica of Antoninus, Temple of Faustina, Exterior (see Plate VII.) and Interior Orders of the Pantheon, Temples of Jupiter Tonans and Jupiter Stator near Rome, and the Temple of Vesta at Tivoli; but there are many other examples which it is not necessary to enumerate in this place.

The pedestal of this order is generally one fourth the height of the column.

COMPOSITE ORDER AT ROME.



Scale of 0 15 30 60 90 120 Minutes.

THE COMPOSITE ORDER

Is, as its name imports, a composed order formed of two others, the Corinthian and the Ionic. It is however received into the number of regular orders by Vitruvius, who has left us its proportions and character. Its capital is a vase covered with two ranges of acanthus leaves, like the Corinthian, but instead of stalks or branches the shoots appear small as if towards flowering, and adhere to the vase, rounding themselves towards the middle of the face of the capital. The vase is terminated just above them by a fillet; an astragal is placed over that, and on the astragal an ovolo; over the ovolo the volutes roll themselves till they meet the tops of the upper row of leaves, on which they seem to rest. The volutes have a great acanthus leaf so bent as to sustain the corner of the abacus. The abacus is like that of the Corinthian capital, but the flower is not supported by a stalk seemingly fixed on the middle of each face of the abacus.

In the detail of its parts, the Composite may be considered richer than the Corinthian capital, but its lightness and delicacy are less striking.

The entablature of the Composite is large for so slender an order; yet it is on many accounts beautiful. It has usually only two fasciæ in the architrave, and its cornice varies from the Corinthian in having, instead of

the modillion and dentil, a species of double modillion which is plain on its surface. The column is of the same height as the Corinthian, and the pedestal and base differ but little from those of that order.

The examples at Rome are in the Temple of Bacchus, the Arch of Septimius Severus, and the Arch of the Goldsmiths, Baths of Dioclesian, and the Arch of Titus, the profile of which example is exhibited in Plate VIII.

HEIGHT AND DIMINUTION OF COLUMNS AND THEIR ENTABLATURE.

THE height of a column in each order is measured by its diameter immediately above the base.

The Tuscan Column is seven diameters in height.

The Doric . . . . eight . . . . . .

The Ionic . . . . nine . . . . . .

The Corinthian . . ten . . . . . .

The Composite . . ten . . . . . .

In the above heights are included the capitals and bases, which are esteemed parts of the column with which they are used. The varieties of the Grecian Doric are not considered. They are referred to the account of that order.

DIMINUTION OF COLUMNS. The shafts of columns are diminished in diameter as they rise: sometimes from the foot itself of the shaft, sometimes from one quarter, and sometimes from one third of its height. The diminution at top is seldom less than one-eighth, nor more than one-sixth of the inferior diameter of the column. In some examples there is a swelling in the middle.

ENTABLATURES. See Plate I. The entablature and its subdivisions, though architects frequently vary from the proportions hereunder given, may, as a general rule, be set up one fourth the height of the column.

The total height thereof thus obtained, is in all the orders, except the Doric, divided into ten parts, three of which are given to the architrave, three to the frieze, and four to the cornice. But in the Doric order, the whole height should be divided into eight parts, and two given to the architrave, three to the frieze, and three to the cornice. The mouldings which form the detail of these leading features are best learnt by reference to representations of the orders at large. Palladio and Vignola, the restorers of genuine architecture, are the authors whose works will be consulted with greatest advantage by those who desire to make any advance in the science, and most particularly by those who wish to obtain further knowledge on the use and abuse of its detail.

PILASTERS.

PILASTERS bear an analogy to columns in their parts, and must have their bases, capitals and entablatures, the same height as those of columns. When used in company with columns, they should be diminished in the same proportion as the columns themselves, or the irregularities occasioned by the passage of the architraves, from undiminished pilasters to diminished columns, besides the difficulties which occur in distributing the modillions and other parts of the entablature, will be extremely unpleasant. Palladio, Vignola, and our own countryman, Jones, have employed both sorts of pilasters, but that which is diminished is nevertheless preferable.

When principal in a composition, pilasters should project one fourth of their diameter, which gives great regularity to the returned parts of the capitals in the Corinthian and Composite orders. But under particular circumstances, as when they are used in a north front, on which there is but little shadow, or when cornices, fasciæ, or the like, mark the separation of two stories, their projection may be greater. In the first case they gain that importance by their retiring sides, when viewed obliquely, which from defect of shadow they would otherwise want; and in the other case, they serve for the reception of those mouldings which

would otherwise project beyond their face, and have a disagreeable effect. When pilasters stand behind and at some distance from their accompanying columns, a projection equal to one-sixth of a diameter will not be too much, as in porticoes, &c. When they range in the same front line with columns, they of course can never project in any case less than their semi-diameter, be the columns ever so much engaged in the wall. If the columns are quite disengaged, the angular pilaster should always be coupled with a column, to hide its retiring flank, and thus take off its otherwise disproportionate appearance in an oblique view of the building.

Crowds of pilasters and columns, seeming to penetrate each other at internal angles, are to be avoided; they are in the worst taste, and produce a confused and disagreeable effect from the irregularities they occasion in their entablatures and capitals. More than one break of this sort, and that only in an interior angle, can never be necessary.

PEDESTALS.

A PEDESTAL, see Plate I. though by no means a necessary appendage to an order, is so frequently used with it, that it requires our notice. It has three parts: the plinth, the die, and the cornice.

The height of pedestals is from one-third to three-tenths the height of the column; but it must be observed in profiling an order, that the die ought never to be less in height than the width of the plinth belonging to the column it supports, and of course its width cannot be less, or the plinth of the column would overhang.

The whole height of a pedestal should be divided into nine parts, or, if it be a low pedestal, into eight, one of which is given to the cornice, two to the base, and the remainder to the die. The projection of the cornice should be sufficient to throw the rain clear off from the plinth. The die, unless the work be very large, should not be decorated nor sunk panelled.

It is only under very peculiar circumstances that pedestals should be permitted under columns entirely disengaged and standing at a distance from the main wall. In such cases, a balustrade, or other continued fence, should be employed to connect the pedestals with each other, by which practice an appearance of solidity is given to these substructions.

INTERCOLUMNIATIONS, ETC.

THE space between two columns is called an intercolumniation. When columns are attached to the wall, this space is not under such rigorous laws, as when they are quite insulated; for in the latter case, real as well as apparent solidity requires them to be near each other, that they may better sustain the entablatures which it is their office to carry.

The different intercolumniations had the following names bestowed on them by the Greeks, and they still retain their ancient appellations.

PICNOSTYLOS, when the columns are once and a half of their diameter distant from each other.

SYSTYLOS, when their distance from each other is two diameters.

EUSTYLOS, when their distance from each other is two diameters and a quarter.

DIASTYLOS, when their distance from each other is three diameters and a quarter.

ARÆOSTYLOS, when their distance from each other is four diameters.

In the Doric, however, the intercolumniation is regulated by the disposition of the triglyphs in the frieze, for the triglyph ought always to be placed over the centre of a column, and the metopa should be square. In the Tuscan intercolumniation, the architraves being of wood, the space may be considerably extended.

A strict adherence to the above-named intervals between the columns, produces some irregularity in the arrangement of the modillions and dentils of the Corinthian, Ionic and Composite cornices, which, though not offensive, is better avoided. Vignola therefore, has, with some propriety, made his eustylos intercolumniation equal to two diameters and one-third in all but the Doric order.

COUPLED COLUMNS. See Plate I. When, from the extent between columns, sometimes necessary for the introduction of doors, windows, niches, or other decorations, neither the eustylos nor the diastylos intercolumniation can be used, coupled columns are frequently introduced. In this case two systylos intercolumniations are used; the column, which would otherwise occupy the middle of the space, being brought to the distance of only half a diameter, or sufficient room for the projection of the capitals, from the extreme column. The middle space is then three diameters and a half. This species has been called Aræosystylos. When buildings are small, the intercolumniations will not require such particular attention to the foregoing rules, for columns should never be placed nearer to each other than three feet, which will allow for the easy passage of ordinary persons.

CARYATIDES, ETC. Caryatides, Persians and Termini, sometimes usurp the office of columns and pilasters. These are male or female figures, or sometimes half of either, springing out of a square shaft diminished downwards, called a Terminus. The male figures are

denominated Persians, Telamones, or Atlantides; the female, Caryans or Caryatides. These figures are also called stylagalmatic from their performing the office of a column.

ORDERS UPON ORDERS. When one order is used over another, the most massive should ever be the undermost; the Tuscan lowest, then the Doric, Ionic, Corinthian and Composite. When columns stand over each other, their axes should all be in the same perpendicular plane as regards the front of the building to which they are attached; though on the flank there is no necessity for adhering to that precept: but when they stand out at a distance from the main body of the building, both the one and the other condition must be preserved. Scamozzi's rule for the diameters of upper columns is, that their lower diameters should be equal to the upper diameters of the columns whereover they stand.

The practice of using order upon order has altogether a meagre appearance, and introduces, without remedy, great irregularities into the entablatures of the superior orders, from the necessarily enlarged intercolumniations created. The second order is usually raised on pedestals continued through the story, or connected by balustrades. In some cases it is raised on a plinth. Where arcades fill up the intercolumniations, either a pedestal or a high plinth is absolutely necessary.

PLATE IX

J. Rotte sc

Jos. Gwilt

ARCADES AND PIERS.

ARCADES, see Plate IX. though not so magnificent as colonnades, are of extraordinary beauty when well contrived; they afford shade from the sun, and shelter from the rain, and are therefore to be commended for their utility as well as their beauty.

The piers of arcades may be decorated with columns, pilasters, niches, and apertures of different forms. The arch itself may be turned either with rock-worked or plain rustic arch-stones or voussoirs, or with an archivolt properly moulded. The key-stone is generally carved in the form of a console, or sculptured with some head, or device. The archivolt springs from an impost or platband, and sometimes from columns, but this is not to be practised except in cases of the most urgent nature, for it makes neither substantial nor beautiful work.

In arches that are of large dimensions, the key-stone should never be omitted; its carving however may be dispensed with, if expense be an object. When the piers are decorated with disengaged columns, the entablature must break round over the columns; and the columns whether engaged or not should stand either on a pedestal or high plinth, by which means they will

not only be kept dry, but their bases will likewise be protected from accidental damage.

Arches must always rise from an impost or plat-band; and if there be no key-stone to the archivolt, its summit should be kept down from the underside of the architrave of the accompanying order, at least half the distance that it would be, were a key-stone employed, in order that the disagreeable appearance of the acute angle which it would otherwise form with the architrave, may be avoided.

The height of arches to the underside of their crowns should not exceed twice their clear width, nor should it be much less. The piers ought not to be less than one-third the breadth of the arch, nor more than two-thirds, but the piers at the angles should be wider than the other piers, by one-half or one-fourth at least.

IMPOST, ARCHIVOLT, ETC. Plates I. and IX. The height of the impost is to be from one-ninth to one-seventh of the width of the aperture, and the breadth of the archivolt not more than an eighth, nor less than a tenth of it. The breadth of the underside of the key-stone should be the same as the breadth of the archivolt, and its sides of course concentric. Its length once and a half its breadth, but at all events not more than double its breadth.

THE THICKNESS OF THE PIERS must necessarily be regulated by the depth of the arcade, so as to be capable of resisting the pressure of the vaulting. It should not, however, in respect of architectural beauty, exceed

one-third the breadth of the arch, nor be less than one-quarter of it.

Scamozzi lessened his piers and varied his imposts and archivolts in proportion to the delicacy of his orders. Vignola's practice was uniform for all the orders.

BASEMENTS AND ATTICS.

As an alternative for employing orders upon orders, the ground floor is made to assume the appearance of a basement, and the order that decorates the principal story is placed thereupon. In such cases the basement should not be higher than the order it supports, nor lower than one half the height of the order, but if a basement be introduced merely for the purpose of raising the principal or ground floor, it may be three, four, five, or six feet, at pleasure.

Basement stories are generally in rock-worked or plain rustics; and in no case should the height of a rustic course be less than one module of the order resting on the basement, nor should it ever much exceed it. Their joints, if square, ought not to be broader than one-eighth of the height of the rustic, nor narrower than one-tenth, and their depth should equal their breadth: if chamfered, the whole joint may be one-quarter to one-third the height of the rustic, the joint being always right-angled. When high, it is sometimes crowned with a cornice, but a platband is more commonly used.

Attics. Attics should not be less than one-quarter, nor more than one-third of the order they surmount:

they are frequently decorated with small short pilasters, whose breadth ought to be equal to the upper diameter of the column immediately below them, and their projection usually not more than one-quarter of their breadth.

PEDIMENTS AND BALUSTRADES.

PEDIMENTS (see Plate I.) represent the gables of roofs, and on a large scale should not be employed but as a crowning to a large portion at least of the front. No member of architecture has been more abused than this. There are but two species of pediments allowable, the triangular rectilineal pediment, and that whose form is the segment of a circle, but the latter should only be used over doors and windows, for the sake of variety. The height of pediments is from one-fifth to one-quarter of the extent of their base. The tympanum of the pediment should be in the same plane with the frieze below it.

BALUSTRADES. See Plate I. Balustrades when intended for use, as against windows, on flights of steps, terraces, and the like, should not be more than three feet six inches, nor less than three feet in height. When used for ornament, as on the summit of a building, their height may be from two-thirds to four-fifths of the entablature whereon they are employed: and this proportion is to be taken exclusive of their zoccolo or plinth, so that from the proper point of sight the whole balustrade may be exposed to view. There are various species of balusters. If single bellied, the best way is to divide the total height of the space allotted for the balustrade into thirteen equal parts, the height

of the baluster to be eight, of the base three, and of the cornice two of those parts; or divide the total height into fourteen parts, making the baluster eight, the base four, and the cornice two. If double-bellied, the height should be divided into fourteen parts, two of which are to be given to the cornice, three to the base, and the remainder to the baluster.

The distance between two balusters should not be more than half the diameter of the baluster in its thickest part, nor less than one-third of it, but on inclined planes, as in the case of steps, the intervals should not be quite so wide.

GATES AND DOORS, ETC.

GATES and doors are generally, whether arched or square, twice their breadth in height. The former may be ornamented with columns, pilasters, entablatures, pediments, rustics, imposts, archivolts, &c. the latter with architraves round the sides and top of the opening, and crowned with a frieze and cornice. The cornice in this case is very frequently supported by a console on each side. Columns, pilasters, and other ornaments, are also sometimes employed in the decorations of doors.

Inside doors should not be narrower than two feet nine inches, nor less than six feet six inches in height. Entrance doors three feet six inches, to six feet six inches broad in private dwellings; but in public buildings, where crowds of people assemble, they must be considerably larger. The smallest width for a gate is eight feet six inches.

As some general rule for the proportion of the architraves of common dressings to doors may be useful, the following directions may be safely followed: suppose the height of the aperture to represent the height of a column; then if an architrave, frieze, and cornice, or the first only, be desired, take them in the proportion that would serve for the order itself, and return the architrave down the sides of the door. The whole

entablature over a square-headed door should never exceed one-third the height of such aperture.

WINDOWS. Windows, though their proportions vary in the different stories of a building, are subject to the same sort of regulations that attach to doors in regard to their dressings. What is called the Venetian window, is subject, however, to laws of its own, not very easily defined.

NICHES. Niches are of two sorts, square or circular-headed, recessed square on the plan; and circular or elliptical-headed, recessed on circular or elliptical plans. The statues or groupes that they are to receive, must regulate their size and proportion. Their height should be at least double their breadth, or at most twice and a half their breadth; they should never be placed between columns and pilasters, unless there be plenty of room for them. The space between the extreme breadth of the niche and the adjoining column or pilaster, ought not to be less than one-sixth of the diameter of the column.

In placing figures in arched niches, Palladio's rule was, that the chin should be level with the top of the impost. Ornaments round niches that are occupied by statues should be sparingly employed, lest they interfere with the principal ornament which is the figure itself.

THE PROPORTIONS OF ROOMS, ETC.

THE proportions of rooms should be suited to the purposes for which they are to be used. All figures from the square to once and a half the breadth of the room, may be employed for the plan. Some have extended the plan to a double square; but it is not an easy matter to give the proportions an agreeable appearance, when the sesquialteral is exceeded. The length of galleries, however, may be from five to eight times their breadth. Their height, if with flat ceilings, is not required to be so great as in those that are coved. The heights of square apartments should not exceed five-sixths the side of the square, nor be less than four-fifths; but in rooms that are oblong, the height ought to be equal to the breadth.

The height of square rooms that are coved should be equal to one of the sides of the square, but coved oblong rooms require a height equal to the breadth, added to one-fifth, one-quarter, or at most one-third of the difference between their length and breadth.

The height of galleries should be from one and three-fifths at most, to one and one-third at least, of their breadth.

Cornices and dressings in the interior of houses are always to be kept more delicate than those on the outside.

CEILINGS. When the ceilings of rooms are coved, the height of the cove should be regulated by the total height of the room. If we have the opportunity of proportioning the height of the room to its superficial dimensions, the best proportion for the cove is one-quarter to one-fifth of the whole height.

STORIES. Palladio directs that the height of the story immediately above the principal floor be a sixth part less than that below, and if there be an attic or third story, it should be nine-twelfths of the height of that immediately under it.

STAIR-CASES.

STAIR-CASES should be light, spacious, and easy; seeming to invite people to ascend. Principal stair-cases should not be narrower than four feet, so that if two persons meet thereon, they may pass each other with convenience; but they may be extended in breadth to ten or twelve feet, according to the importance of the building. The steps should never exceed six inches in height, nor be less than four inches; but this latter height is only allowable in very wide stair-cases. The breadth of the flat horizontal part, which is called the *tread* of the step, should not be less than a foot, nor exceed fifteen inches.

Stairs are planned either straight or winding, the former are those which *fly* forward in a right line; the latter turn or wind in their direction round about a solid or an open newel, and are triangular or trapezoïdal in form. Those steps called direct or plain fliers, proceed in a direct line from one floor to another. Square fliers are such as fly round the sides of a solid or open newel with a square step, called a quarter-space, at each corner of the newel. Triangular fliers fly round the sides of a triangular solid or open newel with a trapezoïdal half step at each angle of the newel, consisting of two hundred and forty degrees, or two-thirds of a circle. French fliers first fly directly

forwards till within the length of a stair of the wall, they then have a quarter-space, from which you ascend immediately to another quarter-space, and thence the stairs return in an opposite flight parallel to their first direction. Winding stairs are those that always wind and never fly; some round a circle, others round an ellipsis, others round a square or an equilateral triangle, either with a solid or open newel, each stair pointing to the centre of the newel. Winding take up less room than straight stairs, and are on that account sometimes very serviceable. In those stair-cases that wind round a solid newel, its diameter varies from one-sixth of the diameter of the whole stair-case in the smallest, to three quarters thereof in the largest stair-cases. Palladio advises that the newel round which the stairs wind, if open, should be half the diameter of the whole stair-case; but why different proportions should be adopted in those with solid and those with open newels, he does not state. Mixed stairs are those composed of winders and fliers; of this sort, is what is termed the dog-legged stair-case, in which the stairs fly first directly forwards, then winding round in a semi-circle fly directly backwards parallel to their first direction.

VAULTS, GROINS AND DOMES.

BUILDINGS and their apartments are sometimes covered by means of VAULTING instead of flat or coved ceilings. Where this is substituted for a roof or floor, it is of course of brick or stone; but in cases where it is used merely for changing the form of an apartment, as in halls, galleries and other divisions of an edifice, it is usually formed with timber cradling and ribs, which are afterwards plastered.

The most simple conditions of vaulting are such as are cylindrical (Plate V.* fig. 2) A A, the section being semi-circular or segmental, or cylindroïdal when the section is semi-elliptical on either axis of the ellipsis; both these sorts are by the Italians called *mezzabotte.*

If the vault A A (Pl. V.* fig. 2) be crossed by another B B of the same height, the lines of intersection are denominated groins, x x; but if the arch be lower than the first, the groin, as y y, is called a Welsh groin. These the Italians term *volte a crociera.*

The next conditions are those in which a vault is formed by a hemisphere, or portion of a hemisphere; or in case the plan be quadrilateral or polygonal, by gores of a cylindrical or cylindroïdal vault mitred at their junction: this arrangement is called a DOME. (See Pl. V.* fig. 3.)

If a hemisphere or other portion of a sphere be intersected by cylindrical or cylindroïdal arches, vaults

a a are formed, which are called pendentives: the termination of these at top will be a circle whereon may be placed a dome, or an upright drum-story, which, if necessary may be terminated by a dome. It is evident that these first lines of vaults and domes are very fruitful in their results, and that by modifications they will furnish the student with hints for an almost infinite variety of vaults. The earliest example of the use of pendentives, is in the celebrated church of Saint Sophia at Constantinople, erected in the reign of Justinian. It may be here observed, that every apartment on a square or polygonal plan, may be contrived to terminate circularly above, so as to carry a dome and cupola if required, by means of pendentives, inasmuch as every plane vertical section of a hemisphere is a semi-circle whose springing points may be set on all squares or regular polygons. So of portions of hemispheres, in which cases the vaults will be segmental or cylindroïdal.

ABUSES.

ARCHITECTURE, says Palladio, being an imitatrix of nature, delights in that which is most consonant with her prototype. The ancient edifices being of wood, and trees themselves forming the columns, when architects, says our author, began to build with stone, they made the columns to imitate the trunks of trees, tapering from their bases. Being thus originally of wood, and therefore liable to split when much loaded, they bound them with rings at top and bottom, to prevent their splitting. Thus the bases and capitals in the different orders seem originally derived from these bandages, though they are now become essential ornaments. Thus also in entablatures, the triglyphs, modillions and dentils, are supposed to represent the ends of those beams and timbers which are employed for the support of the floors and roofs. If, therefore, all these conditions be duly considered, those practices in building are highly to be reprobated which are in opposition to that analogy which should exist between the original and its imitation; or which depart from nature and the simplicity observable in all her works. So far Palladio: but there is, notwithstanding, reasonable doubt, though it cannot here be entered into, whether stone buildings are imitations of their timber precursors.

Consoles or cartouches, which are of a scroll-like

form, should never be employed for the apparent support of great weights, in place of columns or pilasters; nor should they ever project from or spring out of cornices.

Pediments and frontispieces over doors and windows or elsewhere, should on no account be broken or unconnected in the middle, for their use is to shelter the parts below from the rain, and this result is completely obviated by such a practice.

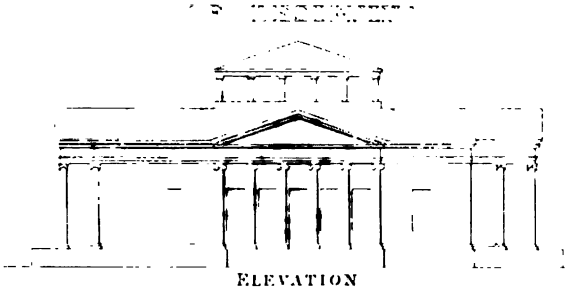
The projecture of cornices, though for the purpose of sheltering buildings, should not be more than in due proportion to their height, whether or not accompanied by columns; for if too heavy, they seem to threaten with danger those who retreat thereunder for shelter; and if too small in projection, they do not properly perform their office.

Again, those columns which are feigned to be composed of several pieces, by being jointed together with rings, should be carefully avoided, because the more solid and strong the columns appear, the better they seem to execute the purpose for which they were erected, which is securely to receive the superincumbent loading.

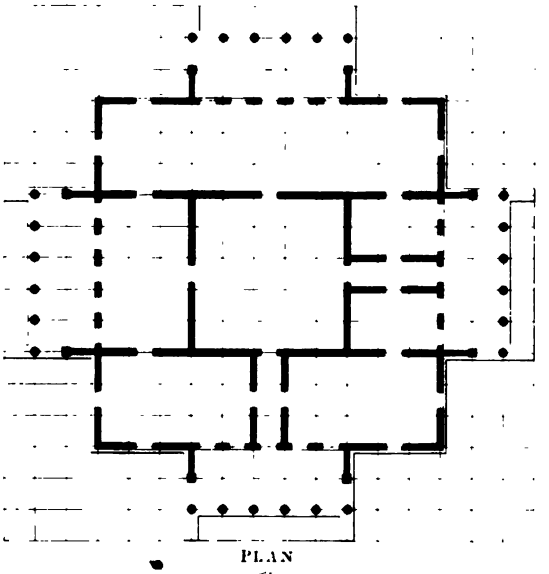
There are many other abuses which the authority of great masters may sanction, but not justify; such will often occur to the student, and will be naturally condemned as matters that ought to be instantly rejected.

DESIGN.

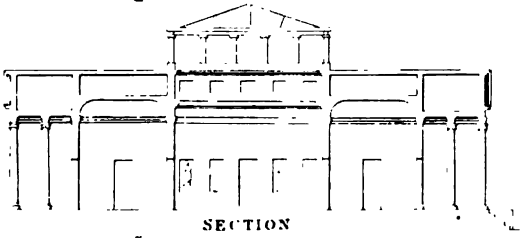
THE art of designing edifices consists in a proper arrangement of the horizontal and vertical masses and voids whereof they are composed, so that the two together may mutually suit each other. The first-named arrangement is made on the plan; the last-mentioned is formed by a transference of the lines of the horizontal masses from the plan to the elevation and section. If a building be formed with a regular order of columns, it is manifest that the horizontal, and consequently the vertical arrangement, must depend, or ought to depend, on their diameters and intercolumniations, when the work is intended to be symmetrical. To insure symmetry, no way is so excellent for the convenience of the student, in his first attempts towards design, as the subdivision of his plan into an odd number of interaxal divisions of the columns, as may be seen in Plate X., which is here exhibited to shew him the system that may be adopted in this respect. From this design, though not to be considered in any other light than as an exemplification of the system, he will immediately learn that the variety to which this mode of treating the subject will lead him in the disposition of both horizontal and vertical masses, is almost infinite; and that, by changing on the plan, the internal forms of a square or rectangle, by divisions in odd numbers,



ELEVATION



PLAN



SECTION

no less than by the introduction of mixed figures, such as squares added to rectangles, the converse, and occasionally those of the circle or portions of it, no bounds can limit his imagination and invention. By this principle he may produce many novel combinations for staircases as well as for other parts of his composition. In central circular apartments, if decorated with columns internally, the middle interaxal space of the front or fronts, may determine the intercolumniations opposite to them, to the right and left of the four vertices of the circle that circumscribes the apartment.

The interaxal divisions will insure symmetry, and in the vertical arrangement he may proceed to assign the height of two or more stories to some parts, whilst others are kept down to a single story as pyramidal effect or the contrary may be desirable. Though the vertical arrangements, which arise from the height of the order, according to its diameter, are not less simple than those which are horizontal, from which indeed they spring; yet each horizontal arrangement may lay the foundation for many vertical ones: for instance, by the number of stories assigned, either to the whole or parts of the whole, by the adoption of arcades, or by other modifications which the nature of the design may lead him to adopt, guided however by the rules hereinbefore given, in respect of their relative proportions. Although this system may appear to belong more properly to public or large buildings, than to private or small ones, the principles are the same in both, and if, in designing even the smallest house, he will keep in

mind that the use of the orders and their accessories may be applied to it, though omitted in reality for the sake of economy, he will invariably produce a work which possesses a grace far beyond the reach of the common artisan or builder.*

* The above system has been carried to a great extent by J. L. N. Durand in his "Précis des Leçons d'Architecture," 4to. Paris, 1823, being the substance of Lessons on Architecture delivered by him at the Ecole Polytecnique at Paris.

SECTION IV.

A CURSORY VIEW

OF

ANTIENT ARCHITECTURE.

THE temples of Egypt were imposing more from the grandeur of their general masses, than from aught abstractedly beautiful and elegant in their detail; they enclosed but a comparatively small cell, which was probably entered by none but the priests themselves. Obelisks, colossal statues, alleys of sphinxes or lions, generally formed the approach to them. Flat roofs terminating in an immense fillet which crowned an enormous cavetto, afforded fine terraces for the use of the priest in his astronomical observations, perhaps his chief occupation. Walls engraven with hieroglyphics, not inelegantly arranged, stupendous blocks of granite and porphyry highly polished, tall obelisks and colossal sitting statues, carved out of a single piece of stone, and pyramids of tremendous dimensions, give the works of the Egyptians a more than human appearance, to which sentiment the perfect state in which they remain after a lapse of forty centuries, not a little contributes.

The simple form of the Greek Temple, with its

elegant detail, double and sometimes triple peristyle, is calculated to charm, that of the Egyptian to surprise. A roof, with a gentle inclination continued from the front to the rear of the temple, formed at those parts, gables or pediments which were often decorated by the sculptor. The Doric order shone in these with all its majesty; its metopæ afforded more scope for the sculptor's talents, and its masculine character seems to have resembled the heroic valour of the people who adopted it. The Greeks appear to have preferred it to the Ionic and Corinthian orders.

The Romans followed the Greeks in the general forms of their temples, but added to their splendour, by a greater richness of detail and the employment of other orders. For the simple steps on which the Greek Temple was elevated, they substituted pedestals, and added a base to the Doric order. The climate prescribed a more elevated pediment, but the luxury of the people was evidently the cause of the preference given to the richer orders of architecture. The temples of the ancients were according to Vitruvius of seven species, viz. 1. In Antis, 2. Prostylos, 3. Amphiprostylos, 4. Peripteral, 5. Dipteral, 6. Pseudodipteral, 7. Hypæthral.

1st. The Temple in Antis was that in which the front antæ or pilasters with two columns between them formed the front of the sacred enclosure; the whole of them supporting the entablature and pediment.

2d. The prostylos in which, though there be antæ, columns are carried out beyond them in the front only

of the temple, which arrangement distinguishes it from the

3d. Amphiprostylos, in which this portico or porch existed in the rear as well as the front of the temple.

4th. Peripteral, in which the temple is surrounded by columns. It is of course *ex vi termini* amphiprostylos, and cannot have less than six columns in front, which will leave the space of one intercolumniation on the sides of the cell.

5th. Dipteral: in this the temple is also surrounded by columns, but as in the peripteral the space of only one intercolumniation is used between the columns on the flanks and the side walls of the cell, in this species that arrangement is changed to a double row of columns on each side of those walls. This arrangement must be at least octastylos, or with eight columns in front and rear.

6th. Pseudodipteral. Here though the number of columns in front is the same as in the dipteral, those columns are left out which should stand between the outer ones on the flanks and the cell, thereby giving a pseudo or false appearance in front.

7th. Hypæthral is a temple whose cell is not covered by a roof.

The Monopteral is a temple built on columns without walls enclosing a cell, and the merely peripteral encloses one: these are both circular.

The principal edifices of the Greeks, the remains of the greater portion whereof are temples, have been already enumerated in the account of the orders given

in a preceding part, and from those remains we may pronounce that their passion for magnificence and splendour, combined with the greatest simplicity of parts, was carried to the highest degree of refinement. Nor is this to be considered extraordinary when it is recollected that many of these structures were built and maintained at the joint expense of all the states of Greece, such as those at Delphi, Delos, Ephesus, and many others. The temples were supported out of revenues issuing from lands, independent of those arising from private donations. The influence of the principles of strictly Greek architecture extended along the coast of Asia Minor, penetrated into Egypt and probably through the cities which Alexander built on his route into India itself. On the west side it is traced in Italy and Sicily. Besides the care bestowed on their temples, the Greeks constructed many other public buildings of considerable splendour. Such were their Fora, Stadia, Theatres, Choragic monuments and Tombs. As these however differ but little from those of the Romans, their architectural disciples, their general features may be gathered from the following particulars of the buildings of that people. From the account given by Vitruvius it may be inferred that the villas of the Greeks were of great extent, and contrived with a view to considerable comfort. The circumstance of separate suites of apartments being allotted to the reception of each guest, is a proof of great advances towards the perfect contrivance in distribution of the whole, and of the convenience they would afford in the

economy of the household. Their ordinary dwellings, however, are generally understood to have been but mean.

The chief temples of Rome, were those on the Capitoline or Tarpeian Mount erected by Tarquinius Superbus: they were burnt in the year of the city 670, rebuilt by Sylla, and dedicated five years after, again burnt A.D. 70, and rebuilt by Vespasian, burnt a third time, and restored by Domitian with great magnificence. No traces of them at present remain. The edifice of the capitol was about two hundred feet square, and contained three temples, consecrated to Jupiter, Minerva, and Juno. On the capitol were also the temples of Terminus, Jupiter Feretrius, and the cottage of Romulus.

The Pantheon, built by Agrippa the son-in-law of Augustus, and dedicated to Mars and Venus, or more probably from its name to all the gods. Pope Boniface IV. consecrated it in honour of the Virgin Mary and All Saints A.D. 607. It is now generally known by the name of the Rotonda. Its diameter between the axes of the columns is one hundred and forty-seven feet: like most of the antient buildings, it has fallen a prey to the spoiler. The Baldachino in St. Peter's is indebted for its materials to the Pantheon of Agrippa.

The Temple of Apollo on the Palatine Hill was built by Augustus. A Temple of Diana stood on the Aventine.

The Temple of Janus was supposed to have been built by Romulus; that of Romulus by Papirius. Of

those to the Sun and Moon, Fortuna Virilis, Vesta, Minerva Medica, Neptune, Antoninus and Faustina, Concord, Jupiter Stator, and most particularly of the Temple of Peace, considerable remains are fortunately still in existence. The three magnificent arches of that last named now standing, though of themselves majestic, convey but a faint idea of its pristine splendour. Of the Temple of Jupiter Stator, whose columns, capitals, and entablature formed a perfect example of the Corinthian order, only three columns at present remain. The ruins of the Temple of Antoninus Pius, Claudius, Hercules, Jupiter Tonans, Isis, Romulus, and Venus and Cupid, are still interesting.

No vestiges exist of the Temples to Saturn, Juno, Mars bis Ultor in the Forum of Augustus, nor of numberless others that adorned the city.

The Temples of Balbec and Palmyra are the last of the antient Roman works that lay claim to the appellation of classic architecture. In these invention seems to have found its limits. The reproduction and new adaptation of the detail of the foregoing is all that has been accomplished by succeeding artists.

The Romans not content with the quadrilateral temple, made use of the circular form, as in the Pantheon, Temple of Vesta and others at Rome, and that of the Sibyl at Tivoli. Except in their theatres, and the little work generally known by the name of the Lantern of Demosthenes, the Greeks have left no buildings on a circular plan.

In the time of Dioclesian a new style prevailed in

Italy. The Basilicæ of Constantine, as they existed previous to their restoration, and in short almost all the first Christian churches, were built out of the materials which the old temples afforded in abundance. The Basilica of S. Paolo fuori le Murà contained, till its recent destruction by fire, a large portion of the columns which originally belonged to the Mausoleum of Adrian. The style of these basilicæ may with propriety be termed Roman gothic. This was followed by the Greek gothic, of which examples may be found in most of the cities of Italy, as in the Church of St. Mark at Venice, the Cathedral at Pisa, said to be built by Buschetto da Dulichio, a Greek architect of the eleventh century, and in the Baptistery and Leaning Campanile of the same city: specimens abound also in Bologna, Siena, Venice, Viterbo, Rome, &c. They are chiefly the works of Nicola di Pisa and his scholars.

At the time that the famous Cathedral of Milan, the perfection of the Lombard gothic style, was in hand, Brunelleschi was advancing a step further, and had begun the restoration of classical architecture in the great Dome and Cupola of Santa Maria del Fiore at Florence, its prototype seeming to have been the Temple of Minerva Medica, to which the work has sufficient resemblance to justify the allusion to it. He succeeded in his enterprize, and thus gave a death blow to the Italian gothic of all sorts. L. B. Alberti, Bramante, and Fra. Giocondo restored the use of the orders: Michael Angelo, Raphael, Sangallo, Sansovino, Palladio and Scamozzi completed the change; the

church of St. Peter's rose, and every little city of Italy began to provide itself with a duomo.

FORA. The Fora of the antients were large squares surrounded by porticoes, which were applied to different purposes. Some parts of them answered for market-places, other parts for the public meetings of the inhabitants, still other parts for courts of justice. The Forum also occasionally afforded accommodation for the shows of Gladiators. Rome contained seventeen Fora, of which fourteen were used for the show and sale of goods, provisions, and merchandize, and were called Fora Venalia; the other three were appropriated for civil and judicial proceedings, and hence called *Fora Civilia et Judicialia.* Of the latter sort was the Forum of Trajan.

The Forum of Julius Cæsar was far more splendid than the Forum Romanum; it cost upwards of eight hundred thousand pounds sterling, and stood in the neighbourhood of the Campo Vaccino, to the east of the Temples of Peace, and of Antoninus and Faustina.

In the vicinity of that last named was the Forum of Augustus: the Temple of Mars bis Ultor decorated the centre of it.

The Forum of Nerva, called also the Forum Transitorium, commenced by Domitian, was decorated by Alexander Severus with colossal statues of the Emperors, some of which were equestrian. Parts of this Forum are still in tolerable preservation.

The forum of Trajan, which has lately been accurately traced by means of very extensive excavations, and the demolition of a great number of houses, was by far the most magnificent. The Trajan column formed one of its ornaments, the architect was Apollodorus, and its situation was between the Forum of Nerva and the Capitol.

BASILICÆ. The Basilica, a term now applied to the Cathedrals of Rome, was originally a court of justice. Like the Forum, it was furnished with shops for the merchants and bankers. In the place called the Comitium were four Basilicæ, viz. that of Paulus, the Basilica Opimia, Julia, and Portia; besides these the most considerable were those of Sicinius, Sempronius, Caius and Lucius, Antoninus Pius, and the Basilica Argentariorum, or of the Goldsmiths. Some of less consideration stood in the vicinity of the Forum Romanum.

The modern halls of Italy in some respects answer the purpose of the antient Basilica. Those most worthy of notice are at Venice, Vicenza, Padua, and Brescia.

PRISON, CURIA HOSTILIA, MILLIARIUM AUREUM, and CALIGULA'S GALLERY. Near the Tarpeian Rock stood the famous prison built by Ancus Martius, which was afterwards called Tulliana, from the additions thereto by Servius Tullus. The Curia Hostilia, where the senate frequently met, was the Comitium; at its entrance, close to the Temple of Saturn, was the Milliarium Aureum, the central point from

which all the roads to the different provinces diverged, and near to which ran the gallery, constructed by Caligula, which joined the Palatine and Capitoline Hills. It was constructed with eighty columns of white marble.

PORTICOES. The Porticoes of Pompey, Augustus, Domitian and Nero, were the most celebrated of Rome. The first-named afforded a refreshing retreat from the sun's rays. The Portico of Augustus was constructed with columns of African marble, and was ornamented with fifty statues of the Danaïdes.

Those of Nero, three in number, each said to have been three miles in length, were called Milliariæ, on account of their extraordinary dimensions. They formed part of his palace.

TOMBS. The pyramidal form was generally applied to tombs. In the heroic ages, a cone of earth, whose base was of considerable extent, covered the ashes of the person to be commemorated. This was the practice of the early ages. Men were, however, desirous of triumphing over death, and the Pyramids, as well as numberless other monuments, the names of whose authors are now lost, have proved the vanity of their desires: the memory of man must depend upon deeds of far different nature.

The Pyramid of Caius Cestius, a trifle compared with any one of those in Egypt, is yet enormous, considering the individual to whose memory it was erected. The Tower of Cæcilia Metella, now called the Capo di

Bove, on the Appian Way, is a beautiful specimen of art. The Appian, Flaminian, and Latin Ways, exhibit numberless sepulchres of an interestiug nature. Those which are found with the inscription D. M. or Diis Manibus, contain the ashes of the persons whose names they bear; but the others are mostly cenotaphs, the bodies having been deposited elsewhere.

TRIUMPHAL ARCHES. Triumphal arches may be reckoned among the luxuries of the Romans. Nothing which could tend to perpetuate the fame of the conqueror was omitted in the design. Some of them were with two, some with three passages. The richest were on the Triumphal Way. Those which also served as gates, generally consisted of two openings, one for the carriages passing out of, the other for carriages passing into the city. With the Greeks, a trophy erected on the field of battle, was held of equal importance with the triumphal arch of the Romans, and a breach was sometimes made in the walls to admit the entry of the conqueror. The Roman Senate received the conqueror at the Porta Capena, near the Tiber, which was the entrance to the city from the Appian Way.

The Arch of Augustus at Rimini, has but a single passage, about thirty-three feet wide; it was crowned with a pediment, contrary to the usual practice. This beautiful specimen is now much mutilated.

That called the Arch of the Goldsmiths, at Rome, is a curious example. It is very small, with a single opening, whose crowning is a flat lintel.

The Arch of Augustus, at Susa, a small town just on the Italian side of Mount Cenis, is extremely elegant.

Those of Aurelian and Janus are more singular than beautiful.

The Arch of Pola, in Istria, is only curious on account of its affording a justification of the use of coupled columns, were the authority of the antients necessary for that purpose. It was erected by Salvia Posthuma in honour of Sergius Lepidus and his two brothers.

The Arch of Trajan, at Ancona, is still in tolerable preservation. It has long since been stript of its bronze ornaments, but their absence has not impaired its elegant proportions.

The Arches of Titus at Rome, and Trajan at Benevento, bear considerable resemblance to each other.

That of Gavius, at Verona, called "del Castel Vecchio," no longer exists. The precepts of Vitruvius have been confronted with his practice in this arch, but Vitruvius Cerdo, not Vitruvius Pollio, was the architect.

The Arches of Septimius Severus and of Constantine are with three openings. The latter is decorated with ornaments shamefully stript off from the Arch of Trajan, which, from their absurd application, make us the more disgusted with the barbarism of the robber.

BRIDGES. Rome formerly contained eight bridges. The Pons Sublicius, built by Ancus Martius, near the

Tiber, was of timber, so framed as to require no iron bolts or ties for its security. It stood at the foot of Aventine, and was that which Horatius Cocles defended. It was replaced of stone by Æmilius Lepidus, and then had the name of Æmilianus. Tiberius afterwards repaired it. Finally, Antoninus Pius rebuilt it of marble, whence it obtained the epithet Marmoratus.

The Pons Triumphalis, near the Vatican, is in ruins, few vestiges of it exist. Those who triumphed, passed over this bridge in their way to the capitol.

The Pons Fabricius led to an island in the Tiber; it is now called Quattro Capi. That which led from the island to the right bank of the river, was called Pons Cestius or Esquilinus; it was rebuilt during the reigns of the Emperors Valentinian, Valens, and Gratian.

Pons Janiculi, so called because it led to the Janiculum, and now known by the name of Ponte Sisto, from having been restored by Sixtus IV., was of marble, and built by Antoninus Pius.

Pons Ælius, built by Ælius Hadrianus, is still in existence. It is situated close to the Mausoleum of Adrian. This having changed its name into that of Castel St. Angelo, the bridge has acquired a corresponding appellation.

The Pons Milvius, now Ponte Molle, is a little way out of the city on the road to Florence. On this bridge Cicero arrested the Ambassadors of the Allobroges, and in its vicinity Constantine defeated Maxentius.

Pons Senatorius or Palatinus, is partly remaining, close to the Palatine Mount.

Ponte Salaro is over the Teverone, about three miles from Rome.

The spans of the arches are generally small; yet there are some magnificent exceptions, as in the Ponte del Castel Vecchio at Verona. This consists of three arches, the largest of which is one hundred and seventy feet span; its two other arches are smaller, they diminish from the city, the left bank of the river being considerably lower than the right. The bridge built by Augustus over the Nar, near Narni, on the Flaminian Way, was a single arch of one hundred and fifty feet span. In the later times of the city, bridges were decorated with trophies, colossal statues, triumphal arches, and the like. Such was the case with the Pons Ælius, and the bridge of Augustus at Rimini.

AQUEDUCTS. The country of Rome is covered with the remains of aqueducts, some of which conveyed the water to Rome, from a distance of more than sixty miles.

The first aqueduct, Aqua Appia, was built, according to Diodorus, by Appius Claudius, in the year of the city 441. The water which it supplied was collected from the neighbourhood of Frascati, and it was about one hundred feet above the level of Rome.

The second, Anio Vetus, was begun forty years after the last named, by M. Curius Dentatus, and finished by Fulvius Flaccus. It was supplied from the country beyond Tivoli. Near Vicovaro it is cut through a rock upwards of a mile in length, in which part it is five

feet high and four feet wide. The water of this aqueduct was not good, and therefore only used for the most ordinary purposes.

The third, Aqua Martia, was supplied from a fountain at the extremity of the mountains of the Peligni. This water entered the city by the Esquiline Gate. It was the work of Quintus Martius.

The fourth, Aqua Tepula, was supplied from the vicinity of Frascati.

The fifth, Aqua Julia, was about six miles long, and entered the city near the Porta Esquilina.

The sixth, Aqua Virginis, was constructed by Agrippa, thirteen years after that last mentioned. Its summit in the territory of Tusculum was about eight miles from Rome, which it entered by the Pincian Gate. This water still bears its antient appellation, being called Acqua Vergine.

The seventh, Aqua Alsietina, called also Augusta, from the use to which Augustus intended to apply it for supplying his Naumachia, was brought from the lake whose name it bears.

The eighth, Aqua Claudia, whose summit is about forty miles from Rome, was begun by Caligula, and completed by Claudius. It enters the city at the Porta Nevia, near the Esquiline Mount. The quality of the water which this aqueduct supplies is better than that of any of the other aqueducts.

The ninth, Anio Novus, to distinguish it from the second-named water, was begun and finished by the same persons as the last-mentioned. It is the water of

the Anio, which being exceedingly thick and muddy after the rains, is conveyed into a large reservoir at some little distance from Rome, to allow the mud to subside.

The Aqua Felice is modern, and was erected by Sixtus V. in 1581.

The Popes have, from time to time, been at considerable pains and expense in repairing and renewing the aqueducts, but the quantity delivered is constantly diminishing. In the antient city, the total sum of the areas of the different pipes, about an inch in diameter, through which the above immense quantity of water was delivered, amounted to about fourteen thousand nine hundred superficial inches. A few years ago the supply was reduced to one thousand one hundred and seventy.

The waters were collected in reservoirs called Castella, and thence were conveyed through the city in leaden pipes. The keepers of the reservoirs were called Castellani. Agrippa alone built thirty of these reservoirs during his ædileship. There are five modern ones now standing in the city: one at the Porta Maggiore, Castello dell' Acqua Giulia, dell' Acqua Felice, dell' Acqua Paolina, and that called the Fountain of Trevi.

BATHS. In the later times the bath was always used by the Romans before they went to their supper. The rich generally had hot and cold baths in their own houses, and it was not till the time of Augustus that

the baths assumed an air of grandeur and magnificence. They were called Thermæ, that is, hot baths, though the same pile of building always contained cold as well as hot baths.

Different authors have reckoned as many as eight hundred public baths in Rome. The chief were those of Agrippa, Nero, Titus, Domitian, Caracalla, Antoninus, and Dioclesian. Their vestiges indicate the amazing magnificence of the age in which they were erected. The pavements were mosaic; the vaulted ceilings were gilt and painted, and the walls incrusted with the richest marbles. Some of the finest and best preserved remains of ancient Greek sculpture have been restored to light from these edifices. It was from these that Raphael took the hint for his fantastic decorations of the Vatican, and the first restorers of art drew their resources.

THEATRES. Dramatic entertainments were first introduced at Rome in the three hundred and ninety-first year of the city. In antient times the people stood during the performance. For a considerable period the theatres were mere temporary buildings, constructed of wood; the most splendid of these upon record was that of Marcus Æmilius Scaurus; it was magnificently decorated, and was capable of containing eight thousand persons.

It was in Pompey's second consulship that the first stone theatre was erected; it accommodated forty thousand spectators. To avoid the animadversions of

the censors, for the magistracy did not yet sanction theatrical exhibitions, he dedicated it to Venus.

Several other theatres afterwards arose. That of Marcellus can still be distinctly traced, and part of the circular façade, in tolerable preservation, is singularly elegant. The Theatre of Balbus was also of considerable celebrity.

The theatres were open at top to the heavens, but in times of rain or excessive heat, means were provided for covering them with a species of cloth awning, by which the inclemency of the weather might be wholly or partially excluded. Their general form on the plan was that of the letter D. The seats (gradus) rose behind each other like steps. The front row was assigned for the use of the senators and the ambassadors of foreign states. Fourteen rows behind this were reserved for the equites, and the rest were open for the public generally. The beautiful Olympic Theatre, by Palladio, at Vicenza, was formed on the model of the antient Roman theatres, and furnishes an excellent idea of their effect.

AMPHITHEATRES. Like the theatres, these were at first of wood, and only temporary. The first amphitheatre of stone was built by Statilius Taurus, at the desire of Augustus.

Of all the monuments of antiquity, none is capable of creating such sublime sensations in the mind as the stupendous amphitheatre generally called the Coliseum. It was commenced in the time of Vespasian, and com-

pleted by Titus; the plan of it is oval, and its accommodation was for eighty-seven thousand spectators, who could enjoy the exhibitions therein without crowding each other.

That part in which the gladiators fought was at the bottom, and was called the Arena, from being usually covered with sand to absorb the blood spilt in the savage conflicts for which it was used. The Arena was encircled by a wall called the Podium, which projected at top. The Podium was fifteen or sixteen feet in height: immediately round it sat the senators and foreign ambassadors. As in the theatres, the seats rose at the back of each other; fourteen rows in the rear of the Podium being allotted to the equites, and the remainder for the public generally, who sat on the bare stone; but cushions were provided for the senators and equites. Though open to the sky, the building was occasionally covered by means similar to those used in the theatres.

The amphitheatre at Verona is still in excellent preservation.

NAUMACHIÆ. The Naumachiæ, or buildings for the exhibition of sham naval combats, were somewhat similar on their plans to the Circi, to which purpose also sometimes these latter were appropriated. The amphitheatres were moreover occasionally used for the same sort of display.

Those of Augustus and Domitian were the most magnificent.

CIRCI. The Circus was a long narrow building, whose length to its breadth was generally as five to one. It was divided down the centre by an ornamented barrier called the Spina. These buildings were used for the celebration of games, racing, &c., and sometimes for making harangues to the people.

The first circus of stone is attributed to Tarquin, and was situated between the Palatine and Aventine Mounts.

The Circus Maximus was much improved and altered by Julius Cæsar, who supplied it with water for the purpose of occasionally using it as a naumachia. Augustus made great additions to it, decorating it with the famous obelisk which now stands in the Piazza del Popolo, where it was placed by Fontana in the year 1589, during the Pontificate of Sixtus V. Being much dilapidated, it was repaired under Antoninus, and afterwards embellished with a second obelisk, which has found a resting place in front of the Church of St. John Lateran; where it was set up by the same Fontana. No vestiges of this circus remain.

The Circus of Flaminius, in the vicinity of the Pantheon of Agrippa, was of considerable dimensions and very magnificent.

The Circus Agonalis occupied the site of what is now known by the name of the Piazza Navona.

The Circus of Nero, upon a part whereon some portion of the Basilica of St. Peter's is seated, was a splendid building. The obelisk now standing in the open circular piazza before St. Peter's, belonged to this circus.

Those of Florus, Antoninus and Aurelian, are no longer even in ruins; but that of Caracalla is sufficiently perfect to trace its plan and distribution in the most satisfactory manner. It was seven hundred and thirty-eight feet in length.

HOUSES AND STREETS. "Urbem Marmoream se relinquere quam lateritiam accepisset," was the boast of Augustus, and has been held conclusive as to the meanness of the materials whereof the city was built previous to his reign. The streets, however, in the time of that emperor, were still narrow and irregular. After the great fire in Nero's reign, the city was rebuilt with greater splendour. The streets were then set straight, and considerably broader than before. Those houses wherein several families dwelt were called INSULÆ; DOMUS was the expression for a house occupied by one family only.

We know little of the form of the Roman houses, though Vitruvius has described at sufficient length the different apartments whereof they consisted.

The small houses discovered in the ruins of Pompeii can bear but little, if any resemblance to the houses of the opulent inhabitants of Rome. The most celebrated were those of the Gordians, P. Val. Publicola, Cæsar, Sallust, Mæcenas, Cicero, Verres, Augustus and Lucullus. The domus aurea of Nero was probably the most magnificent in Rome. The Villa of Adrian at Tivoli was so extensive that it almost deserved the

name of a city. Immense ruins of the Palaces of the Cæsars are still to be seen.

PILLARS. Rome was decorated with numberless pillars. The most remarkable are fortunately in an excellent state of preservation, namely, those of Trajan and Antoninus.

The Column of Trajan, as has been already observed, stood in that emperor's forum; it is about twelve feet in diameter at its base, and, including the pedestal, is about one hundred and twenty-five feet in height. The ascent to the gallery, on the top of the abacus of its capital, is by one hundred and eighty-five steps, two feet nine inches long, winding round the column, and lighted by forty openings. A colossal statue of Trajan formerly crowned the top, but St. Peter has long since deposed the emperor.

The Column of Antonine is one hundred and seventy-six feet high; number of steps, one hundred and six, with fifty-six openings for the admission of light. Sixtus V. caused its pedestal to be cased, when, in 1589, the pillar was under repair. It was this Pontiff who elevated St. Peter to his situation, as well on this as on the Trajan Column.

CLOACÆ. The great sewers of Rome are reputed to have been the work of Tarquinius Priscus. The Cloaca Maxima, which still carries some of the filth and waste water of Rome into the Tiber, was the work of Tarquinius Superbus.

VIÆ. The public ways were not only some of the most stupendous, but also the most useful of the Roman works.

The first road which the Romans paved was the Via Appia, so called because it was executed by order of Appius Claudius. He carried it as far as Capua, whence it was afterwards continued to Brundusium, in all a distance of three hundred and fifty miles; it is still entire in many places, though more than twenty centuries have elapsed since its construction; it was properly called "Regina Viarum."

The Via Numicia led to Brindisi (Brundusium); the Via Flaminia to Rimini and Aquileia; the Via Aurelia was along the coast of Etruria; the Via Cassia ran to Modena, between the Flaminian and Aurelian ways; and the Via Æmilia extended from Rimini to Piacenza.

The smaller ways were the Via Prænestina, to Palestrina, the antient Preneste; Tiburtina, to Tivoli; Ostiensis, to Ostia; Laurentina, to Laurentum, south of Ostia, Salaria, &c.

The cross roads were called Diverticula.

SECTION V.

A DICTIONARY

OF

TECHNICAL TERMS USED BY ARCHITECTS AND ARTIFICERS.

ABACUS. The upper member of the capital of a column whereon the architrave rests. In the Corinthian order its four sides are curved inwards in segments of circles on the plan, and are decorated in the centre with a flower or some other ornament. The original object in the use of the abacus was doubtless to give breadth to the top of the column, and prepare a larger surface of level bed for the reception of the entablature. Scamozzi applies this term to a concave moulding in the capital of the Tuscan pedestal, which, considering its etymology, is an error.

ABUTMENT. The solid part of a pier from which an arch immediately springs.

ACANTHUS. A plant called in English, bear's breech, representations of whose leaves are employed for decorating the Corinthian and Composite capitals.

The leaves of the Acanthus are used on the bell of the capital, and distinguish the two rich orders

from the three others. In those two orders they are however differently disposed, as may be seen by reference to the plates of the Corinthian and Composite orders in this work. In the Composite capitals of the Arches of Titus and Septimius Severus, the leaves seem from their strong indentations intended to represent parsley leaves. Those in the Temple of Vesta at Rome differ from the Acanthus, and are usually denominated laurel leaves.

ACROTERIA. The small pedestals placed on the extremities and apex of a pediment. They are usually without bases or plinths, and were originally intended to receive statues. Vitruvius gives rules for their dimensions. Some use the word Acroterion to signify a figure of stone or metal placed on the top of a building, but in its strict meaning the term ought only to be applied to the pedestals above-mentioned.

ALCOVE. The original and strict meaning of this word which is derived from the Spanish Alcoba, is confined to that part of a bed-chamber in which the bed stands, separated from the other parts of the room by columns or pilasters. The seats in gardens have however in this country been designated by this term.

ALTO RELIEVO. See Relief.

AMPHIPROSTYLOS. In antient architecture, a temple with columns in the rear as well as in the front.

AMPHITHEATRE. A double theatre, of an elliptical form on the plan, for the exhibition of the antient gladiatorial fights and other shows. Its Arena or Pit, in which those exhibitions took place, was encompassed with seats rising above each other, and the exterior had the accommodation of porticos or arcades for the public. It was distinguished from a theatre, by its consisting of two theatres placed end to end.

The remains of four very considerable amphitheatres are still in existence. That of Pola in Istria. The Coliseum at Rome, built by Vespasian. One at Verona, and the fourth in Languedoc, near Nismes, besides some others.

ANCONES. The consoles or ornaments cut on the keystones of arches, or on the sides of door-cases. They are sometimes made use of to support busts or other figures.

ANNULET. A small square moulding, which crowns or accompanies a larger. Also that fillet which separates the flutings of a column. It is sometimes called a List or Listella, which see.

ANTA. (Æ plural.) A name given to a pilaster when attached to a wall. Vitruvius calls pilasters PARASTATÆ when insulated. They are not usually diminished, and in all Greek examples their capitals are different from those of the columns they accompany.

ANTEFIXA, in antient architecture. The ornaments of lions' and other heads below the eaves of a temple,

through channels in which, usually by the mouth, the water is carried from the eaves. By some this term is applied to the upright ornaments above the eaves, in antient architecture, which hid the ends of the Harmi or joint tiles.

ANTEPAGMENTA. The architraves round doors.

APOPHYGE. That part of a column between the upper fillet of the base, and the cylindrical part of the shaft of the column, which is usually curved into it by a cavetto.

AQUEDUCT. An artificial canal for the conveyance of water, either above or under ground. The Roman aqueducts are mostly in the former predicament.

ARÆOSTYLOS. That style of building in which the columns are distant four and sometimes five diameters from each other, but the former is the proportion to which the term is usually applied. This columnar arrangement is suited to the Tuscan order only.

ARÆOSYSTYLOS. That style of building in which four columns are used in the space of eight diameters and a half. The central intercolumniation being three diameters and a half and the others on each side being only half a diameter, by which arrangement coupled columns are introduced.

ARCH. A scientific arrangement of bricks, stones, or other materials in a curvilinear form, which by their mutual pressure and support perform the office of a lintel, and carry superincumbent weights,

the whole resting at its extremities upon the piers or abutments.

ARCHITRAVE. The lower of the primary divisions of the entablature. It is placed immediately upon the abacus of the capital.

ARRIS. The line of concourse, edge or meeting of two surfaces.

ASHLER, in masonry. A term used among artificers, by which they designate common freestones, as they come out of the quarry, of different lengths and thicknesses. Nine inches however is their thickness.

ASHLERING, in carpentry, quartering in garrets to which the laths are nailed, about two feet and a half or three feet high, perpendicular to the floor, and reaching up to the underside of the rafters.

ASTRAGAL. A small moulding, whose profile is semicircular. It bears also the name of Talon or Tondino. The Astragal is often cut into representations of beads and berries, and is used in ornamented entablatures to separate the faces of the architrave.

ATTIC BASE. See Base.

ATTIC ORDER. An order of low pilasters, generally placed over orders of columns or pilasters. It is improperly called an order, for the arrangement can scarcely admit of such an appellation.

BACK OF A HIP. The upper edge of the hip rafter, between the two sides of a hipped roof formed to

an angle so as to range with the rafters on each side of it.

BACK OF A RAFTER. The upper side of it.

BACK OF A SLATE. The upper side of it.

BACKER, in slating. A narrow slate laid on the back of a broad square-headed slate, where the slates begin to diminish in width.

BALCONY. A projection from the surface of a wall, usually supported by consoles and surrounded by a balustrade or railing.

BALTHEUS. See Coussinet.

BALUSTER. A small pillar or pilaster, serving to support a rail, see Plate I. Its form is of considerable variety in different examples. Sometimes it is round, at other times square; it is adorned with mouldings and other decorations according to the richness of the order it accompanies.

BALUSTRADE. A connected series of several balusters, as on balconies, terraces, around altars, &c. See Baluster.

BAND. A term used to signify what is generally called a face or fascia. It more properly signifies a flat low square profiled member, without respect to its place. That in a cornice from which the Corinthian and other modillions or the dentils project, is called the modillion band, or the dentil band, as the case may be.

BANDELET. A diminutive of the foregoing term, used to signify any narrow flat moulding. The

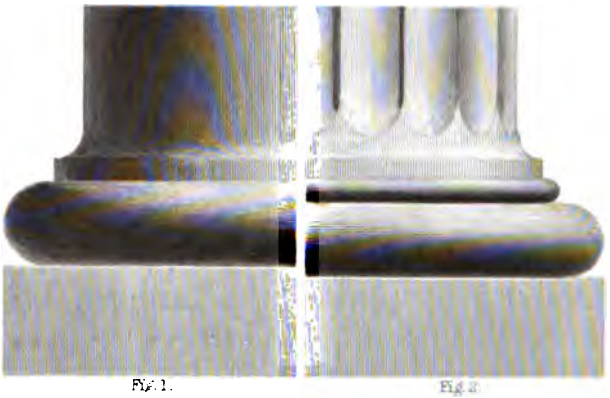


Fig. 1.

Fig. 2.

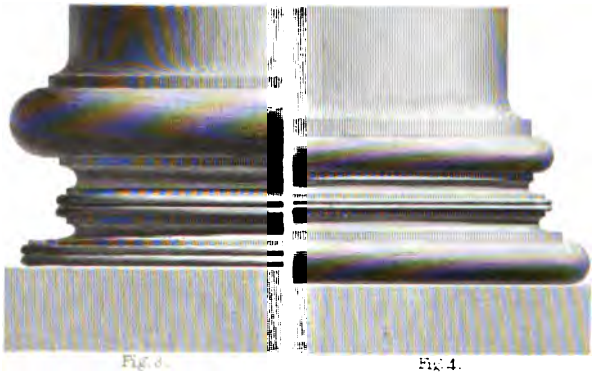


Fig. 3.

Fig. 4.

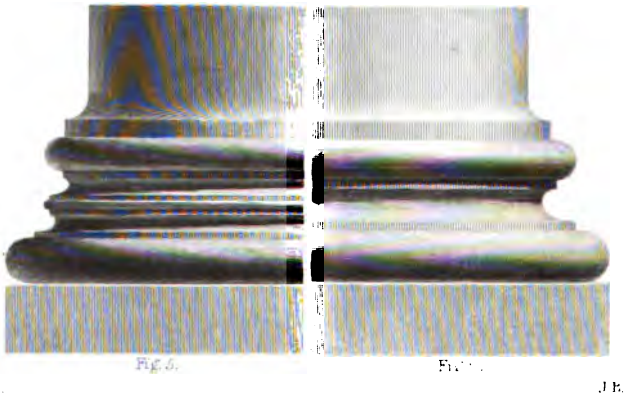


Fig. 5.

Fig. 6.

tænia on the Doric architrave is called its bandelet.

BANQUET, in masonry. The raised footway adjoining the parapet on the side of a bridge.

BAR IRON. A long prismatic piece of iron, being a rectangular parallelopiped, so prepared from pig-iron, as to be malleable for the use of the smith.

BASE. The lower part of a column, moulded or plain, on which the shaft is placed. The word also signifies any support, but is in decorative architecture mostly used in the above sense. The earliest columns, as those of the Grecian Doric, were without bases, standing immediately on the floor or pavement of the portico. The Tuscan base has only a single torus or round member on the plinth, Plate XI. fig. 1. The Roman Doric a torus and astragal, Plate XI. fig. 2. The Ionic, a single large torus placed over two slender scotiæ, which are separated by two astragals, Plate XI. fig. 3. The Corinthian base has two tori, two scotiæ, and two astragals, Plate XI. fig. 4. The Composite has a double astragal in the middle. Plate XI. fig. 5.

Besides the above, there is another species denominated the Attic base, Plate XI. fig. 6. This base consists of two tori, and a scotia; the former are of different dimensions, the upper one being the least, and they are separated from the scotia by a fillet on the top of one and at the bottom of the other.

BASILICA. A town or court hall, a cathedral, a palace, where kings administered justice. The term is particularly applied at Rome, to the churches of Santa Croce di Gerusalemme, San Giovanni Laterano, Santa Maria Maggiore, San Lorenzo fuori le Murà, San Paolo, San Sebastiano, and San Pietro del Vaticano.

BASSO RELIEVO. See Relief.

BASTARD STUCCO, in plastering. Plaster of three coats, the first whereof is generally roughing in or rendering, the second, floating as in troweled stucco, and the third or finishing coat contains a little hair besides the sand. This work is not hand floated, and the troweling is accomplished with less labour than what is denominated troweled stucco.

BATARDEAU. The same as Cofferdam, which see.

BATTEN. A name given by workmen to a piece of fir, from two to four inches broad, and about one inch thick, the length is rather considerable, but undefined.

BATTENING. Narrow Battens fixed to a wall to nail the laths to.

BATTER. A term used by bricklayers, carpenters, &c. to signify a wall, piece of timber, or other material which does not stand upright, but inclines from you when you stand before it; but, when on the contrary, it leans towards you, they say of its inclination that it over-hangs.

BAULK, sometimes called DRAM TIMBER. A piece of

whole fir, being the trunk of a tree of that species of wood, usually squared for the use of building. In London the term is only applied to small lengths from eighteen to twenty-five feet, generally under ten inches thick, tapering considerably, and with the wains so left that the baulk is not brought to an exact square.

BAY, in plastering. The place between the skreeds which is prepared for regulating and working the floating rule. See Skreeds.

BEAD. A moulding whose vertical section is semi-circular. Hence when the edge of any piece is in this form it is said to be beaded.

BEAM. An horizontal piece of timber used to resist a force, or weight, as a tie-beam, which acts as a string or chain, by its tension; as a straining-piece, which acts by compression; as a bressummer, which is for bearing an insisting weight.

BEAM-FILLING. The masonry or brick-work between beams or joists. Its height is equal to the depth of the timbers employed.

BEARER. Any upright piece used by way of support to another.

BED, in bricklaying and masonry. The horizontal surfaces on which the stones or bricks of walls lie in courses.

BED OF A SLATE. The lower side.

BED MOULDINGS. Those mouldings in all the orders between the corona and frieze.

BEVEL. An instrument for taking angles. One side

of a solid body is said to be bevelled with respect to another, when the angle contained between those two sides is greater or less than a right angle.

BINDING-JOISTS. See Joists.

BIRD'S MOUTH. The interior angle or notch cut on the extremity of a piece of timber, so that it may be received on the edge of another piece as a rafter, for instance, is received on the pole-plate. It is a term also used to signify the internal angle of a polygon, the external angle at its point being, in contradistinction, called a Bull's Nose.

BLOCKING-COURSE. The course of masonry or brick-work on the top of a cornice.

BOARD. A piece of timber whose length is undefined, less than two inches and a half in thickness and more than four inches in breadth. The section of a board is sometimes however, of a triangular, or rather a trapezoïdal form, one edge being very thin; such is called a feather-edged board.

BOND, in bricklaying and masonry. That connection between bricks and stones formed by lapping them upon one another in carrying up the work, so as to form an inseparable mass of building, by preventing the vertical joints falling over each other.

BOND, ENGLISH AND FLEMISH, in bricklaying. See pages 73 to 78.

BOND, OR LAP OF A SLATE. The distance between the nail of the under slate, and the lower edge of the upper slate.

BOND-STONES. Stones running through the thickness of the wall at right angles to its face, in order to bind it together.

BOND-TIMBER. Timber laid in walls to tie them together longitudinally while the work is setting.

BOSSAGE, a French term. Any projection left rough on the face of a stone for the purposes of sculpture, which is usually the last thing finished.

BOTTOM-RAIL, in joinery. The lowest rail of a door.

BOULTIN. A name given to the moulding called the egg or quarter round.

BOXINGS. See Linings.

BRACE, in carpentry. An inclined piece of timber, used in trussed partitions, or in framed roofs, in order to form a triangle, and thereby stiffen the framing. When a Brace is used by way of support to a rafter, it is called a Strut. Braces in partitions, and span roofs are, or always should be, disposed in pairs, and introduced in opposite directions.

BREAK. Any projection from the general surface of a building.

BREAKING JOINT. The arrangement of stones or bricks so as not to allow two joints to come immediately over each other.

BRESSUMMER. A beam supporting a superincumbent part of an exterior wall, and running longitudinally below that part, and generally supported by wooden or iron posts.

BRICKNOGGING. Brick-work carried up between quartering.

BRICK TRIMMER. A brick arch abutting against the wooden trimmer under the slab of the fire-place, to prevent the communication of fire.

BRIDGE, in masonry. An edifice or structure, consisting of one, or more arches, raised for passing a roadway over a river, canal, &c.

BRIDGING-JOISTS. See Joists. Also pages 81 and 83.

BULL'S NOSE. The external angle of a polygon, or of any two lines meeting at an obtuse angle.

CABLING. The filling up of the lower part of a fluting of a column, with a solid cylindrical piece. Flutings thus treated are said to be cabled.

CAISSON. A name given to the sunk pannels of various geometrical forms symmetrically disposed in flat or vaulted ceilings, or in soffits.

CAISSON, in bridge building. A chest or vessel in which the piers of a bridge are built, gradually sinking as the work advances, till its bottom comes in contact with the bed of the river, and then the sides are disengaged, being so constructed as to allow of their being thus detached without injury to its floor or bottom.

CAMBER, in carpentry. The convexity of a beam upon the upper surface, in order to prevent its becoming straight or concave by its own weight, or by the burden it may have to sustain.

CANTED. Obtuse angled.

CANTILIVERS. Pieces of wood framed into the front

and sides of a house to sustain the eaves and mouldings over them.

CAPITAL. The head or uppermost member belonging to a column or pilaster, or other part. The capitals of the several orders differ as follows: the Tuscan Capital consists of an abacus or square piece at the top, under which is an ovolo or quarter round, and under that a neck, terminated by an astragal or fillet, which latter is considered as belonging to the shaft of the column. The Roman Doric Capital has an abacus, ovolo, and neck like the Tuscan, but in addition has three annulets under the ovolo and a cyma or ogee, with its fillet over the abacus. The Grecian Doric, however, has only a square abacus, ovolo, and small fillets. The Ionic Capital consists of three principal parts: an abacus composed of an ogee and fillet, a rind, which forms the scrolls, and an ovolo and astragal at bottom. The Corinthian Capital consists of an abacus of peculiar form, (see Abacus,) and a bell covered with leaves and stalks, the leaves forming its under part, and the stalks rising between them, and turning down in the form of scrolls when they reach the abacus. The Composite Capital borrows an ovolo from the Doric, and volutes from the Ionic, and a double tier of leaves from the Corinthian.

CARPENTRY. The art of arranging the main timbers of an edifice.

CARTOUCH. The same as modillion, except that it is

exclusively used to signify those blocks or modillions at the eaves of a house. See Modillion.

CARYATIDES. Figures of women, which serve instead of columns to support the entablature. Their origin, related by Vitruvius, as representing the captive women of Carya, is erroneous. It is probable that they were originally statues in honour of Diana.

CASEMENT. The same as Scotia, which see. Also a term used to signify sashes hung on hinges.

CASTING or Warping, in joinery. The bending of the surfaces of a piece of wood from their original position, caused either by the weight of their own substance or by an unequal exposure to the weather, or by the ununiform texture of the wood.

CATHETA OR CATHETUS. A perpendicular or plumb-line falling from the extremity of the underside of the cymatium of the Ionic Capital through the centre of the volute.

CAULICOLUS. The volute or twist under the flower in the Corinthian Capital.

CAVETTO. A hollow moulding whose profile is a quadrant of a circle, principally used in cornices.

CEILING, in plastering. The uppermost, horizontal or curved surface of an apartment opposite to the floor, generally finished with plastered work. Ceilings are set in two different ways, the best is that wherein the setting coat is composed of plaster and putty, commonly called GAUGE. Common ceilings are formed with plaster, but without hair: the same as the finishing coat in walls set for paper.

CELL. See Naos.

CENTERING. The temporary woodwork on which an arch is constructed.

CINCTURE. A ring, list or fillet at the top and bottom of a column, serving to divide the shaft of the column from its capital and base.

CLAMP, in joinery. A piece of wood fixed to the end of a board with a mortise and tenon, or with a groove and tongue, so that the fibres of the piece thus fixed, traverse those of the board, and thus prevent it from casting: the piece at the end is called a clamp, and the board is said to be clamped.

CLINKERS. Hard bricks imported from Holland. Also those bricks which from being impregnated with a considerable quantity of nitre, or saltpetre, and lying next the fire in the clamp or kiln, from its violence, run together and are glazed over.

CLOSERS, King. See page 75.

CLOSERS, Queen. See page 75.

COARSE STUFF, in plastering. See LIME AND HAIR.

COAT. A thickness or covering of plaster or other work done at one time.

COFFERDAM. A case or cases of piling without a floor, in which the piers of a bridge are built.

COFFERS. The sunk panels which are placed in vaults and domes, often ornamented with flowers in their centres. See Caisson.

COLLAR-BEAM. A beam framed crosswise betwixt two principal rafters above the plates on which they pitch.

COLUMN. A member in architecture, whose vertical section through the axis is generally a frustum of an elongated parabola. Its plan is circular, and it consists of a base, a shaft or body, and a capital. It differs from the pilaster, which is square on the plan. Columns generally stand perpendicularly.

COMPOSITE ORDER. One of the orders of architecture. See page 117.

CONGE. Another name for the echinus or quarter round, as also for the cavetto; the former is called the swelling conge, the latter the hollow conge.

CONSOLE. See Ancones.

CORINTHIAN ORDER. One of the orders of architecture. See page 115.

CORNICE. The projection, consisting of several members, which crowns or finishes the superior part of an entablature, or of any other part to which it is attached. The cornice used on a pedestal, is called the cap of the pedestal.

CORONA. The flat square and massy member of a cornice, more usually called the drip or larmier, whose situation is between the cymatium above, and the bed moulding below; its use is to carry the water drop by drop from the building.

CORRIDOR. A gallery or open communication to the different apartments of a house.

CORSA. The name given by Vitruvius to any platband or square fascia, whose height is more than its projecture.

COUPLED COLUMNS. See Aræosystylos.

COURSE, in bricklaying and masonry. A continued level range of stones or bricks, of the same height throughout the whole length of the building as far as the solid part continues, uninterrupted by any aperture. A COURSE OF PLINTHS is the continuity of a plinth of stone or plaster in the face of a building, to mark the separation of the stones, sometimes called a string course.

COURSE IN SLATING AND TILING. An horizontal tier of slates or tiles.

COUSSINET (a cushion), in architecture. The stone which crowns a piedroit or pier, or that which lies immediately over the capital of the impost and under the sweep. The bed of it is level below and inclined above, receiving the first rise or spring of the arch or vault. The word Coussinet is also used for the ornament in the Ionic Capital between the abacus and the echinus or quarter round, which serves to form the volute. It is thus named from its representing a cushion or pillow pressed by the weight over it and bound with the strap or girdle, called by Vitruvius, Baltheus.

CRADLING. The timber ribs in arched ceilings and coves to which the laths are nailed.

CROSETTES, in architecture. The returns on the corners of door cases or window frames, called also Ears, Elbows, Ancones, Prothyrides.

CROWN, in architecture. The uppermost member of the cornice, called also Corona and Larmier.

CROWN, or King Post, in carpentry. The post which

in roofs stands vertically in the middle between the two principal rafters.

CRYPT. The under or hidden part of a building. The cellar.

CUPOLA. A small room either circular or polygonal standing on the top of a dome. By some it is called a Lantern.

CURB ROOF. See page 88.

CURTAIL STEP. The lower step in a flight of stairs ending at its outer extremity in a scroll.

CUSHIONED. See Frieze.

CYMA, called also CYMATIUM, its name arising from its resemblance to a wave. A moulding which is hollow in its upper part and swelling below. Of this moulding, there are two sorts, the Cyma Recta, just described, and the Cyma Reversa, whose upper part swells, whilst the lowest part is hollow.

DADO, in architecture. The die, or that part in the middle of the pedestal of a column, which is between its base and cornice. It is of a cubic form, and thence takes the name of Die.

DECASTYLOS. A building having ten columns in front.

DENTILS. Small square blocks or projections used in the bed mouldings of the cornices in the Ionic, Corinthian, Composite, and sometimes Doric Orders. Their breadth should be half their height,

and their intervals, according to Vitruvius, two-thirds of their breadth. The Greeks were not accustomed to use them under modillions.

DIASTYLOS. That style in which the intercolumniation or space between the columns consists of three diameters, some say four diameters.

DIDORON. A brick among the antients whose length was one foot and breadth half a foot.

DIE or DYE. A naked square cube. Thus the body of a pedestal or that part between its base and its cap, is called the die of the pedestal. Some call the abacus the die of the capital.

DIGLYPH. Any projecting face with two channels sunk thereon.

DIMINUTION. The gradual decrease of thickness towards the upper part of a column.

DIPTERAL. A term used by the antients to signify a temple which had a double range of columns on each of its flanks.

DISCHARGE. A term used to signify the relief afforded to any part on which a weight is to be borne. Thus DISCHARGING ARCHES are those used in the wall over a lintel to relieve the lintel of the weight which would be otherwise incumbent thereon.

DITRIGLYPH. An intercolumniation above which two triglyphs are disposed.

DODECASTYLOS. A building having twelve columns in front.

DOME. The spherical or other formed concave ceiling

over a circular or polygonal building. *Surbased* or Diminished Domes are those which are segmental on their section. *Surmounted* Domes are those which are higher than the radius of the base.

DOOR FRAME. The surrounding case into and out of which the door shuts and opens. It consists of two upright pieces and a head, generally fixed together by mortices and tenons, and wrought, rebated and beaded.

DORIC ORDER. One of the five orders of architecture.

DORMER in architecture. A window placed on the inclined plane of the roof of a house, or above the entablature, being raised upon the rafters, with its frame in a vertical position.

DOVETAILING, in carpentry and joinery. The method of fastening boards, or other timbers together, by letting one piece into another in the form of the expanded tail of a dove. It is the strongest mode of joining masses, because the tenon, or piece of wood widens as it extends, so that it cannot be drawn out again on account of the extreme or end of the tongue being larger than the hole. This method of connecting pieces is by the French called QUEUE D'ARONDE, i. e. swallow's tail, which term is also used by the English themselves in fortification.

DRAGON BEAMS. Those horizontal pieces of timber on which the hip rafters pitch. They are framed into short diagonal pieces which tie the plates at the internal angles of a roof.

DRAM TIMBER. See Baulk.

DRESSINGS, in joinery. Any mouldings or other finishings.

DRIFT. The horizontal force of an arch, by which it endeavours to overset the piers.

DRIP. See Corona.

DRIPPING EAVES. The lower edges of a roof wherefrom the water drips on the ground.

DRIPS. The inclined steps in which the covering of flat roofs is sometimes formed.

DROPS. See Guttæ.

DRUM. The upright part of a cupola over a dome, Also the solid part or vase of the Corinthian and Composite capitals.

DWARF WALL. Any wall less in height than that story of the building in which it is used.

EARS. See Crosettes.

EAVES, in slating and tiling. The margin or lower part of the slating hanging over the naked of the wall, to throw the water off from the masonry or brickwork.

ECHINUS. The same as the ovolo or quarter round, but perhaps that moulding is only properly called echinus when carved with eggs and anchors, as they are termed. Echinus is the husk or shell of the chestnut, to which it is said, perhaps erroneously, to bear a resemblance.

EGGS. See Echinus.

ELBOWS. The sides or flanks of any panelled work.

EMPLECTON. A species of walling described by Vitruvius.

ENCARPUS. The festoons on a frieze, consisting of fruits, flowers and leaves. See Festoon.

ENTABLATURE. The assemblage of parts supported by the column. It consists of three parts, the architrave, frieze and cornice.

ENTASIS. The swelling of a column.

ENTRESOL. See Mezzanine.

EPISTYLIUM. The same as architrave, which see.

EPITITHIDES. A term used to signify the crown mouldings of an entablature.

EUSTYLOS. That intercolumniation, which, as its name would import, the antients considered the most elegant, viz. two diameters and a quarter of the column. Vitruvius says this manner of arranging columns exceeds all others in strength, convenience, and beauty.

EXHEDRA. A recess in the antient porticos or ambulatories for retirement from the crowd.

EXTRADOS. The exterior or convex curve, forming the upper line of the arch stones: the term is opposed to the intrados or concave side.

EYE OF A DOME. The aperture at its summit.

EYE OF A VOLUTE. The circle in its centre.

FAÇADE. The face or front of any building towards a street, court, garden or other place, more

usually however used to signify the principal front.

FACING. That part of any work which presents itself to the eye of the spectator, and generally enclosing a worse species of work.

FASCIA. A flat member in the entablature or elsewhere, being in fact nothing more than a band or broad fillet. The architrave in the more elegant orders is divided into three bands: these are called fasciæ. The lower is called the first fascia, the middle one the second, and the upper one the third fascia.

FASTIGIUM. See Pediment.

FEATHEREDGED, in joinery. See Board.

FEMUR. See Shank.

FESTOON. An ornament of carved work, representing a wreath or garland of flowers or leaves, or both interwoven with each other. It is thickest in the middle, and small at each extremity, where it is tied, a part often hanging down below the knot.

FILLET. The small square member which is placed above or below the various square or curved members in an order.

In carpentry or joinery it is a small piece to which boards, joists or quarters are nailed.

FINE STUFF, in plastering. A composition of lime slacked and sifted through a fine sieve, mixed with a proper quantity of hair, and sometimes a small portion of fine sand. Fine stuff is used in

common ceilings and walls set to receive paper or colour.

FINISHING COAT, in plastering. The best coat of three coat work, when used for stucco. The term setting is usually employed when the third coat is made of fine stuff for paper.

FIRST COAT, in plastering of two coat work, is denominated laying when on lath, and rendering when on brick; in three coat work upon lath it is denominated pricking up, and upon brick roughing in.

FLASHINGS. Pieces of lead let into the joints of a wall, so as to lap over gutters or other pieces.

FLATTING. A coat of paint which, from the action of the turpentine used therein, leaves no gloss on the surface.

FLOATED WORK. That which is pricked up, floated, that is, made of a perfectly plane surface by means of a tool called a float, and set, or roughed in floated and set.

FLOATED LATH AND PLASTER, set fair for paper. Three coat work, the first whereof is pricking up, the second floating, and the third or setting coat of fine stuff, understood to be pricked up, no floating being executed without pricking up.

FLOATING SKREEDS, in plastering. Strips of plaster to float to; in cornices, wooden moulds edged with metal, are used for the execution of the work.

FLOOR, in architecture. The underside of the room, or that part whereon we walk. Floors are of several

sorts, as of earth, of brick, stone, usually called pavement, and of wood.

Carpenters by the word floor understand as well the framed work of timber as the boarding over it. Earthen floors are commonly made of loam, and sometimes, as in the case of malting floors, of lime and brook sand, and gun dust, or anvil dust from the forge. See Folded and Straight Joint Floors.

FLUE. The open concealed aperture of a chimney from the fire-place to the top of the shaft.

FLUSH. The continued surface in the same plane, of two contiguous masses.

FLUTES or FLUTINGS. The vertical channels on the shafts of columns, which are usually rounded above and below. They are sometimes circular or segmental, and sometimes elliptical on their horizontal section. In the Doric order they are twenty in number, in the other orders, the Tuscan excepted, which is never fluted, their number is usually twenty-four. They are occasionally cabled. See Cabling.

FOLDED FLOOR. That in which the boards are laid in divisions, whose side vertical joints are not continuous, but in bays of three, four, five or more boards in a bay or fold: in opposition to a straight joint floor in which the side joints of the boards are continuous throughout their direction.

FOOTINGS. The spreading courses at the base or foundation of a wall.

FRAMING. The rough timber work of a house, including the flooring, roofing, partitioning, ceiling and beams thereof.

FRET or FRETTE. A kind of continued knot or ornament, consisting of one or more small fillets running vertically and horizontally, and at equal distances in both directions. The sections of the channels below the surface of the fillet are rectangular.

FRIEZE or FRIZE. The middle member in the entablature of an order, which separates the architrave and cornice. In the Tuscan order it should always be plain. In the Doric it is ornamented with triglyphs. In the Ionic it is sometimes swelled, and in the Corinthian and Composite is variously decorated at the pleasure of the architect. When it swells in the Ionic order, it is called a pulvinated or cushioned frieze.

FRONTISPIECE. The face or fore front of a house, but it is a term more usually applied to its decorated entrance.

FURNITURE. The external brass-work of locks, knobs of doors and window-fastenings, &c.

FURRING, in carpentry. The bringing a piece of sunk framing to a regular surface, by nailing thin pieces thereon. Thus when rafters are cut with a knee, the furring consists of pieces which go straight along with the rafter from the top of the knee to the cornice. And when they are rotten or sunk hollow in the middle, it consists of pieces cut

thickest in the middle, and tapering towards each end, which are nailed upon them to make them straight. Such pieces are called Furs, and the putting them on is called furring the rafters. So in the case of joists, &c.

FUST. The shaft of a column. See Shaft.

GABLE. The upright triangular piece of wall at each end of a roof from the eaves to the summit.

GAGE. See Gauge.

GAUGE, in plastering. A mixture of fine stuff and plaster, or putty and plaster, or coarse stuff and plaster, used in finishing the best ceilings, and for mouldings, and sometimes for setting walls.

GAUGE, in slating and tiling. The length of slate or tile below the lap. See Bond.

GIRDER. The principal beam of a floor for supporting the binding joists, by which the bearing of the joists is lessened. See page 82.

GLYPH. A vertical channel sunk on a tablet. Those of the Doric frieze are, from their number, called Triglyphs.

GOLA, or GULA. The same as Ogee, which see.

GORGE. The same as Cavetto, which see.

GROINS. The lines formed at the intersection of two arches which cross each other.

GROOVE, in joinery. A term used to signify a sunk channel whose section is rectangular. It is usually employed on the edge of a moulding, stile

or rail, &c. into which a tongue corresponding to its section, and in the substance of the wood to which it is joined, is inserted.

GROUND PLATE or SILL. The lowest plate of a wooden building for supporting the principal and other posts.

GROUNDS, in joinery. Pieces of wood flush with the plastering to which the wooden finishings are attached.

GROUT. Semi-liquid mortar.

GUILLOCHE. An ornament composed of fillets in curvilinear directions, which form a continued series by their repetition.

GUTTÆ. Those frusta of cones in the Doric architrave, under the triglyph in the Doric order, which occur below the tænia. They are also found in the under part of the mutuli or modillions of that order. Sometimes they are, as in the Greek examples, a little curved inwards on their profile.

HAMMER-BEAM. An horizontal piece of timber introduced towards the lower part of a rafter acting as a tie.

HARMUS. In Greek architecture. The tile which covers the joint between two common tiles.

HEADERS. In bricklaying and masonry. Bricks or stones with the short face in front.

HEADING COURSES, in bricklaying and masonry. Those in which bricks and stones are laid entirely with headers.

HELIX. The curling stalk under the flower in the Corinthian capital. See Caulicolus.

HEXASTYLOS. A building having six columns in front.

HIPS. The inclined pieces of timber at the angles of a roof; hence a hipped roof is that in which all the four sides have the same inclination to the horizon.

HOLING, in slating. The piercing of the slates for nails.

HOUSING. The space taken out of one solid to admit of the insertion of another.

HYPÆTHRAL. In the open air, or uncovered by a roof.

HYPERTHYRUM. The lintel of a doorway.

HYPOTRACHELION. The neck of a capital.

JACK TIMBERS, in carpentry. Timbers shorter than the whole length of other pieces in the same range.

JAMBS. The side pieces of any opening in a wall, which bear the piece that discharges the superincumbent weight of such wall.

ICHNOGRAPHY. The plan of a building.

JIB-DOOR. A door so constructed that it stands flush with the adjoining face of the wall on each side, and without dressings or architraves, so that it may appear part of the wall.

IMPAGES. Usually supposed to mean the rails of a door.

IMPOST. The capital of a pilaster supporting an arch. The impost varies in form according to the order

with which it is used. Sometimes the entablature of the order, or a part of it, serves for the impost of an arch. Also, *ex vi termini*, any supporting piece.

INCERTUM OPUS. A species of walling used by the antients wherein the face appears of irregularly sized stones.

INSERTED COLUMN. One let into a wall.

INSULATED. Detached from another building. A church is insulated, when not contiguous to any other edifice. A column is said to be insulated when standing free from the wall; thus the columns of peripteral temples were insulated.

INTERCOLUMNIATION. The distance between two columns.

INTERTIE, in carpentry. A horizontal piece of timber framed between two posts, in order to tie them together.

INTRADOS of an arch. The interior or concave curve of the arch stones.

INVERTED ARCHES. Those whose key stone or brick is the lowest in the arch.

JOGGLE PIECE. A truss post, with shoulders and sockets for receiving the lower ends of the struts.

JOGGLED JOINTS. Joints of stones or other masses, so indented as to prevent the one from being pushed away from the other by a force perpendicular to the pressures by which they hold together.

JOINERY. The art of framing wood for the finishing of houses.

JOISTS. Those timbers in a floor which support, or are necessary to the support of the boarding or ceiling, as the binding, bridging, and ceiling joists. Girders are however to be excepted, as being larger timbers for the support of joists.

IONIC ORDER. One of the five orders of architecture.

ISODOMUM. A species of walling among the antients, wherein the height of every course is equal.

KEY, in joinery. A piece of wood inserted into the back of another, whose grain runs in a contrary direction, to prevent the latter from warping.

KEY STONE. That stone in an arch, which is equally distant from its springing extremities. In a circular arch there will be two key stones, one at the summit and the other at the bottom thereof; in semi-circular, semi-elliptical arches, &c. it is the highest stone, and it is frequently sculptured on the face and return sides.

KING POST. The middle post of a trussed piece of framing for supporting the tie beam at the middle and the lower ends of the struts.

KNEE. A piece of timber naturally or artificially bent to receive another to relieve a weight or strain.

LACUNAR (plural IA) and LAQUEAR. The same as Soffit, which see. It is however to be observed, that it is a lacunar only when consisting of compartments

sunk or hollowed, without the separation of plat-bands or spaces between the panels. When they are added it is called laquear.

LANTERN. A square, circular, or polygonal erection on the top of a dome or other apartment to give light. See Cupola.

LARMIER. Called also Corona, which see.

LATH. A slip of wood used in slating, tiling and plastering. Laths are of two sorts, single and double. Double fir laths are three-eighths of an inch thick, single fir laths being barely a quarter of an inch. All the ceilings on the entrance and drawing-room floors and best staircases should be lathed with double fir laths. Single fir laths are something less than a quarter of an inch in thickness. Pantile laths are long pieces of fir on which the pantiles hang. Those used for plaintiling are similar to those above described, but should always be of oak.

LATH, FLOATED AND SET FAIR, in plastering. The same as lath pricked up, floated and set, which see.

LATH, LAID AND SET, in plastering. Two coat work, except that the first coat, called laying, is put on without scratching, unless it be swept with a broom. This is generally coloured when used on walls, and whited when on ceilings.

LATH, PLASTERED, SET AND COLOURED. The same as lath, laid, set and coloured.

LATH, PRICKED UP, FLOATED AND SET FOR PAPER. Three

coat work, the first is pricking up, the second floating, and the finishing is executed with fine stuff.

LAYING, in plastering. The first coat on lath of two coat plaster or set work: it is not scratched with the scratcher, but the surface is roughed by sweeping it with a broom: it differs only from rendering by its application being to laths. Rendering is used to signify the first coat upon brick, whereas laying is the first of two coat work upon lath.

LIME AND HAIR, in plastering. A mixture of lime and hair used in first coating and floating. It is sometimes denominated coarse stuff: in floating more hair is used than in first coating.

LEANTO. A building against another, in which the rafters of the former lean against the latter.

LEAVES. Ornaments representing natural leaves. The antients used two sorts of leaves, natural and imaginary. The natural were those of the laurel, palm, acanthus and olive, but they took such liberties in the form of these that they may almost be said to have been imaginary too.

LEDGERS. Horizontal pieces of timber in scaffolding, parallel to the wall opposite to which they are erected.

LINING, in joinery. The covering of an interior surface. Thus the linings or boxings of window-shutters are the pieces which form the backs of the recesses into which the shutters fold. In a door they are the facings on the sides of the

aperture. To a sash frame they are the vertical pieces parallel to the surface of the walls.

LINTEL. A piece of timber or stone placed horizontally over a door, window, or other opening.

LIST, or LISTEL. The same as fillet or annulet.

LISTING, in carpentry and joinery. The operation of cutting away the sap from the edge or edges of a board.

LUFFER BOARDING. Inclined boards placed above one another in an aperture so as to admit air without permitting the rain to penetrate.

LUNETTE. An aperture in a concave ceiling to admit light, such as the upper lights in the nave of St. Paul's Cathedral in London. It is a French term.

LUTHERN. The same as Dormer, which see.

LYING PANELS. Those in which the fibres of the wood lie horizontally.

MANSARD or CURB-ROOF. See page 88.

MANTLE. The horizonal cross-piece placed on the jamb of a chimney.

MARGIN OF A COURSE, in slating. That part of the back of a slate exposed to view.

MEROS. The plain part of a triglyph. That part between the channels.

METOCHE. The space between two dentils.

METOPA (Æ, plural). The square space between two triglyphs of the Doric order. It is sometimes left plain, at other times decorated with sculpture.

MEZZANINE. A low story introduced between two principal stories.

MIDDLE RAIL, in joinery. That rail of a door which is level with the hand. The lock of the door is generally fixed on this rail.

MINUTE. The sixtieth part of the diameter of a column. It is the sub-division by which architects measure the smaller parts of an order.

MITRE. The diagonal junction of two pieces of wood, stone, etc.

MODILLION. An ornament in the entablature of the richer orders, resembling a bracket. Modillions are placed, with the intervention of one or two small horizontal members, under the corona. They should be so distributed that their centres may always stand over the centres of the columns. In the Corinthian Order they are enriched with carving; in the Ionic and Composite they are generally more simple. The term Mutulus, which is confined to the Doric Order, is in fact the same as modillion. The mutuli should always stand over the triglyphs.

MODULE. A measure signifying the semi-diameter of a column. This term is only properly used when speaking of the Doric order. As a semi-diameter, it consists of only thirty minutes. See MINUTE, and page 111.

MONOPTERAL. Among the antients, a circular, sacred enclosure, by means of columns, without a cell.

MONOTRIGLYPH. The arrangement in which only one triglyph is placed over an intercolumniation.

MONTANT. A French term, signifying an upright piece in framing.

MORTISE, in carpentry. A species of joint, wherein a hole or incision of a certain depth is made in the thickness of a piece of wood for the reception of another piece called a tenon.

MOSAIC WORK. An assemblage of small pieces of pebbles, pieces of glass of various colours, or other pieces of materials, cut square and laid on a species of stucco, to form pavements, representations of pictures on walls, &c.

MOULDINGS. Those parts of an order which are shaped into various curved or square forms.

MOUTH. The same as Cavetto, which see.

MULLION, or MUNNION, in architecture. The short upright post or bar which divides any two lights in a window frame.

MUTULUS. See MODILLION.

NAKED. The unornamented plain surface of a wall, column or other part of a building.

NAKED FLOORING, in carpentry. The timber work of a floor for supporting the boarding or ceiling or both. See page 79.

NAOS, or CELLA. The part of a temple within the walls. That part of the temple in front of the Naos was called the Pronaos, and that in the rear

the Posticum. This is the etymon of our English word nave.

NAVE. See preceding word.

NECK OF A CAPITAL. The space between the astragal above the shaft and the annulet thereover.

NEWEL. The solid, or imaginary solid when the stairs are open in the centre, round which the steps are turned about.

NICHE. A square or cylindrical cavity in a wall or other solid, generally for the reception of a statue.

NOGGING. Brickwork carried up between quarters.

NOGGING PIECES. The horizontal pieces of timber in bricknogging, placed between and nailed to the quarters to strengthen the work.

NOSINGS OF STEPS. The rounded projecting edges of the treads or covers of the steps.

NOTCH BOARD. The board in a staircase notched or grooved out to receive the ends of the steps.

NUT, of a screw. A piece of iron pierced with a cylindrical hollow, whose circumference contains a spiral groove. The internal spiral of the nut is adapted to an external cylindrical spiral on the end of a bolt. The use of the bolt and nut is to screw two bodies together, a head being wrought on one end of the bolt in order to counteract the action of the nut. By this means the two bodies are held together by compression, and the bolt between the head and the nut becomes a tie.

OBELISK. A tall slender frustum of a pyramid, usually placed on a pedestal. The difference between an obelisk and a pyramid, independent of the former being only a portion of the latter, is, that it always has a small base in proportion to its height.

OCTASTYLOS. A building with eight columns in its front.

ODEUM. In antient architecture, a place appropriated to the performance of music.

ŒCUS. In antient architecture, an apartment adjoining to a dining-room.

OFFSET. The upper surface of the lower part of a wall left, by reducing the thickness of the superincumbent part, on one side or the other, or both.

OGEE or OGIVE. The same as Cyma, which see.

OPISTHODOMUS. The enclosed space in the rear of a temple.

ORDER. An assemblage of parts, consisting of a base, shaft, capital, architrave, frieze, and cornice, whose several services requiring some distinction in strength have been contrived or designed in five several species, Tuscan, Doric, Ionic, Corinthian, and Composite; each of these has its ornaments, as well as general fabric, proportioned to its strength and use. These are the five orders of architecture, the proper understanding and application of which constitute the foundation of all excellence in the art.

ORDONNANCE. A French term, signifying the general arrangement of a design, and the disposition of its several parts.

ORLO. The plinth of the base of a column or pedestal.

ORTHOGRAPHY. A geometrical representation of the elevation or section of a building.

OVERHANG. See Batter.

OVOLO. A moulding sometimes called the quarter round, from its profile being the quadrant of a circle; when sculptured it is called an Echinus, which see.

OVUM. The same as Ovolo.

PALÆSTRA. In Grecian architecture. A building appropriated to the purposes of wrestling, running, &c.

PANEL or PANNEL, in joinery, &c. A tympanum or square piece of thin wood, sometimes carved, framed or grooved into a larger piece between two montants or upright pieces, and two traverses or cross pieces.

PARAPET. From the Italian *Parapetto,* breast high. The defence round a terrace or roof of a building.

PARASTATÆ. Pilasters standing insulated. See Anta.

PARGET. The plastering used in coating the internal surfaces of chimnies.

PARTY WALLS. The brick or stone division between buildings in separate occupations.

PATERA. The representation of a cup in bas relief, used as an ornament in friezes, fasciæ, and imposts.

PAVILLON. In old French architecture, the projecting apartment at the flanks of a building.

PEDESTAL. The substruction under a column or wall.

A pedestal under a column consists of three parts, the base, the die, and the cornice or cap.

PEDIMENT. The low triangular crowning ornament of the front of a building, or of a door, window or niche. Pediments are however sometimes in the form of the segment of a circle when applied to doors and windows. The pediment of a building is not unfrequently ornamented with sculpture.

PENDENTIVE. See page 141.

PENTADORON. A species of bricks used by the antients and mentioned by Vitruvius.

PERIBOLUS. The space enclosed by a wall, wherein a temple was placed.

PERIDROME. The space, in antient architecture, between the columns and the wall.

PERIPTERAL. A term used by the antients to signify a building encompassed by columns, forming as it were an aisle round the building.

PERISTYLIUM. In Greek and Roman buildings, a court, square, or cloister, which sometimes had a colonnade on three sides only, and therefore in that case improperly so called. There were other peristylia with a colonnade on each of the four sides; that on the south side was sometimes higher than the rest, in which case it was called a Rhodian Peristylium.

PERITHERIDES. See Ancones.

PIAZZA. A square open space surrounded by buildings. This term is ignorantly used to denote a walk under an arcade.

PIEDROIT. A French term, signifying a pier or square pillar partly hid within a wall. It differs from a pilaster by having neither base nor capital.

PIER. A solid between the doors or windows of a building. The square or other formed mass or post to which a gate is hung. The solid support from which an arch springs. In a bridge, the pier next the shore is usually called an abutment pier.

PIG IRON. Short thick bars of iron, as they come from the smelting furnace.

PILASTER. A square pillar engaged in a wall.

PILES, in building, are large timbers driven into the earth to make a foundation to build upon in marshy ground. Amsterdam and some other cities are wholly built upon piles. The stoppage of Dagenham Breach was effected by piles mortised into one another by a dovetail joint.

PILLAR. A column of irregular form, always disengaged and always deviating from the proportions of the orders, whence the distinction between a pillar and a column.

PISE'. A species of walling made of stiff earth or clay, rammed in between moulds as it is carried up.

PITCH, OF A ROOF. The inclination which the sloping sides make with the plane, or level of the wall plate; or the proportion which results from dividing the span by the height. Thus, if it be asked what is the pitch of any given roof, the answer is, one-fourth, one-third, or one-half: when the pitch is one-half, the roof is a square, which

is the highest that is used, or that is necessary in practice.

PLANCEER. The same as Soffit, which see.

PLANK. A board exceeding nine inches in breadth. See Board.

PLASTER. The material with which ornaments are cast, and with which the fine stuff of gauge for mouldings and other parts is mixed.

PLATBAND. A square moulding, whose projection is less than its height or breadth. The fillets between the flutes of columns are improperly called Platbands. The lintel of a door or window is sometimes called by this name.

PLATE, in carpentry, a horizontal piece of timber in a wall, generally flush with the inside face thereof, for the reception of the ends of beams, joists or rafters, and denominated a floor, roof, or other plate, accordingly.

PLINTH. The square solid under the base of a column, pedestal, or wall. The abacus of the Tuscan capital is sometimes called the Plinth of that capital.

PLUG. A piece of wood driven into a wall in an horizontal direction, whose end is sawn away flush with the wall into which it is driven, for the purpose of affixing by nails any required dressing.

PORTICO. A place wherein persons may walk under shelter, sometimes raised with arches in the manner of a gallery. The portico is occasionally vaulted, but has frequently a flat soffit or ceiling.

This word is also used to denote the projection before a church or temple, supported by columns.

POSTICUM. The back door of a temple, also the portico behind the temple. See Naos.

POSTS. All upright or vertical pieces of timber whatever, as truss-posts, door-posts, quarters in partitions, &c.

PRICK-POSTS. Intermediate posts in a wooden building, framed between principal posts.

PRICKING-UP, in plastering. The first coating of three coat work upon laths. The material used is coarse stuff, sometimes mixed up in London with road dirt or Thames sand, and its surface is always scratched over.

PRINCIPAL. Any main timber in an arrangement of carpentry.

PROFILE. The contour of the different parts of an order.

PRONAOS. See Naos.

PROPYLÆUM. In Grecian architecture. A portico placed in front of gates.

PROSCENIUM. That part of the stage of a theatre before the drop scène. In the antient theatres it comprised the whole of the stage.

PROSTYLOS. A building or temple with columns in front only.

PROTHYRIDES. See Ancones.

PROTHYRUM. The porch at the outer door of a house.

PSEUDODIPTERAL. A term used by the antients to signify a building or temple, in which the distance

from each side of the cell to the surrounding columns, was equal to two intercolumniations, but wherein the intermediate range of columns which would occur between the outer range and the cell was omitted.

PSEUDO-ISODOMUM. A species of walling mentioned by Vitruvius.

PUGGING, in plastering. The stuff laid upon sound-boarding, in order to prevent the transmission of, or deaden the sound in its passage, from one story to another.

PULVINATED. A term used to express the swelling of the frize in the Ionic order.

PUNCHEONS. Any short posts of timber. The small quarterings in a stud partition above the head of a door, are called Puncheons.

PURLINES, in building. Those pieces of timber that lie on the principal rafters, to prevent the common rafters from sinking in the middle of their length.

PUTLOGS. Short pieces of timber at right angles to the walls used in making scaffolds.

PUTTY. A very fine cement made of lime only. It is thus prepared: dissolve in a small quantity of water, as two or three gallons, an equal quantity of fresh lime, constantly stirring it with a stick until the lime be entirely slaked, and the whole becomes of the consistency of mud; so that when the stick is taken out of it, it will but just drop therefrom; this being sifted or run through a hair sieve, to take out the gross parts of the lime, it is

fit for use. Putty differs from fine stuff in the manner of preparing it, and in its being used without hair.

PYCNOSTYLOS. An intercolumniation equal to one diameter and a half.

PYRAMID. A solid with a square, polygonal, or triangular base, terminating in a point at top.

QUARTER ROUND. See Ovolo and Echinus.

QUARTERS and QUARTERING. Quarters, in carpentry, are those upright pieces of timber, used in partitions, whereto the laths are nailed. They are of two sorts, single and double; the single quarters are sawn stuff two inches thick and four inches broad; the other quarters are generally sawn to a scantling of four inches square, or four inches by three or by two and a half. It is a rule in carpentry that no quarters be placed at greater distance than fourteen inches.

Quartering, in carpentry, signifies the putting in of quarters. Sometimes it is used for the quarters themselves.

QUEEN POST. See page 88.

QUIRK, in building. A piece of ground taken out of any ground-plot or floor. Thus, if the ground-plot were square or oblong, and a piece be taken out of a corner to make a court or yard, &c. the piece is called a Quirk.

QUIRKED MOULDINGS. Those which are suddenly

convex, generally in one of the forms of a conic section.

QUOINS. The external and internal angles of buildings or of their members: the corners.

RAFTERS, in carpentry. All the inclined timbers in the sides of a roof; as principal rafters, hip rafters, and common rafters, which, in the provinces, are usually otherwise called spars.

RAIL, in joinery. A horizontal piece which receives the tenons in a piece of framing, and into which the upper and lower edges of the panels are inserted.

RAISING PLATE, or TOP PLATE. That plate on which the roof is raised, or immediately placed.

RAMP. A concave bend in the capping of any piece of workmanship. Thus in stairs it is that concavity which occurs over risers or over a half or quarter space, (see page 138,) by the sudden rise of the steps.

REBATE, in joinery. A groove, channel, or recess, sunk on the edge of a board.

RECESS. A part whose surface is within the general surface of the work.

REGLET. The same as Listel.

REGULA. The same as Listel.

RELIEF. The projection which a figure or ornament has, from the ground or plane on which it is sculptured. When the whole of the figure stands out, the work is said to be in Alto Relievo. When

only half out, in Demi Relievo, and when it projects very little, in Basso Relievo.

RENDERED and FLOATED, in plastering. Three coat work, more commonly called floated, rendered, and set.

RENDERED FLOATED, and SET FOR PAPER, would be more properly termed roughed in, floated, and set for paper, and is three coat work: the first, lime and hair upon brickwork; the second, the same stuff with a little more hair floated with a long rule; the last, fine stuff mixed with white hair.

RENDERED and SET. The same as set work. Rendering is the first of two coat work upon naked brick or stone work, whited on walls or vaults; roughing in being the first coat of three coat work on naked brick, but the compound term Pricking-up is used for the first of three coat work upon lath, or on brickwork, which has been previously rendered. Though the term rendering is sometimes used in three coat work, it is improper. The material for rendering is the same as that for pricking-up.

RENDERING. See preceding word.

RETICULATED WORK. That in which the courses are arranged in a form like the meshes of a net. The stones or bricks are square and placed lozenge-wise.

RIBS. Curviform timbers whereto the laths are nailed in an arched or coved plaster ceiling.

RIDGE. The piece of wood against which the rafters pitch on the top of a house or other building.

RING. A name sometimes given to the list, cincture or fillet.

RISER. The upright part of a step.

ROMAN ORDER. Another name for the Composite.

ROOF. The uppermost part of a building. The roof contains the timber-work and its covering of slate or tile, or whatsoever is used as a cover, though carpenters usually restrain the use of the word roof to the timber-work only.

ROSE. The representation of this flower is carved in the centre of each face of the abacus in the Corinthian Capital, and is called the Rose of that capital. It is also used in decorating the caissons in the soffit of the corona, and in those of ceilings.

ROUGH CAST, in plastering. The overlaying of walls with mortar and fine gravel without smoothing it with any tool whatever.

ROUGHING IN. See Rendered and Set.

ROUGH STUCCO. That which is finished with stucco floated and brushed in a small degree with water, and is much in use at present.

RUSTIC. The courses of stone or brick in which the work is jagged out into an irregular surface. Also work left rough without tooling.

SAG. The bending or curvature in the middle which a horizontal piece of timber takes from its own gravity.

SALON. An apartment for state, or for the reception of

paintings, and usually running up through two stories of the house. It may be square, oblong, polygonal or circular.

Sash. The frame-work which holds the squares of glass in a window balanced by weights on each of its sides, hung thereto by lines running over pulleys at the top of the sash frame. When both the upper and lower sashes are moveable up and down, a sash is said to be double hung; when only one of them moves, they are said to be single hung.

Sash Frame. The wooden frame into which the sashes are fitted.

Scantling, in building. A measure, size, or standard, whereby the dimensions, &c. of things are to be determined.

Scapus. The same as Shaft of a Column, which see.

Scenography. The perspective representation of a building and its scenery.

Sciography. The doctrine of shadows.

Scotia. The name of a hollowed moulding, principally used between the tori in the bases of columns: it derives its name from the darkness which its form creates; *σκοτία*, signifying darkness. It is sometimes called a casement, sometimes trochilus, from its resemblance to a common pulley.

Screeds. Wooden rules for running mouldings. Screeds are also the extreme guides upon the margins of walls and ceilings for floating to, the intermediate ones being called Bays. In running cornices,

where the ceilings are not floated, there must always be screeds.

SECOND COAT, in plastering. Either the finishing coat, as in laid and set, or in rendered and set, or it is the floating, when the plaster is roughed in, floated and set for paper.

SET FAIR, in plastering, is used after roughing in, and floated or pricked up and floated; it should be well troweled, as it does not otherwise answer for colour.

SET WORK, in plastering. Two coat work upon lath; the plasterers denominate set work by the compound term of Laid and Set.

SETTING. The quality that any kind of stuff has to harden in a short time.

SETTING COAT, on ceilings or walls, in the best work, is gauge, or a mixture of putty and plaster, but in common work it consists of fine stuff, and when the work is very dry, a little sand is used. The setting coat may be either a second coat upon laying or rendering, or a third coat upon floating; the term finishing is applied to the third coat when of stucco, but setting for paper.

SHAFT. That part of a column which is between the base and capital: it is also called the Fust as well as the Trunk of a column.

SHANK. A name given to the insterstitial spaces between the channels of the triglyph in the Doric frieze. They are sometimes called the legs of the triglyph, and sometimes femora.

SHINGLES, in building. Small pieces of wood or quartered oaken boards, sawn to a certain scantling, or more usually cleft to about an inch thick at one end, and made like wedges, four or five inches broad, and eight or nine inches long. They are used in covering, more especially on churches and steeples, instead of tiles or slates.

SHORE. A piece of timber placed in an oblique direction for the security of a wall or other matter.

SILL. The horizontal piece at the bottom of any framing.

SKEW BACK, in brickwork and masonry. The sloping abutment for the arched head of a window.

SKIRTING. The narrow vertical board, standing on the floor round the sides of an apartment.

SKREEDS. See Screeds.

SLEEPERS. Pieces of timber on which the ground-joists of a floor rest, or those laid under the planking in a bad foundation. The term was formerly applied to the valley rafters of a roof.

SOCLE. A square member of greater breadth than height, usually the same as plinth.

SOFFIT. The ceiling or under side of a member in an order. It also means the under side of the larmier or corona in a cornice; also the under side of that part of the architrave which does not rest on the columns. See Lacunar.

SPANDREL. The space about the flanks or haunches of an arch or vault above the intrados.

SPARS, in carpentry. The term by which the common

rafters of a roof are best known in almost every province in Great Britain, though generally called in London common rafters, to distinguish them from the principal rafters.

SPRINGING. The lower part of an arch.

STANCHEONS. See Puncheons.

STEENING. The brick lining of a well.

STEREOBATA or STYLOBATA. The same as Pedestal.

STILES. The vertical parts of any piece of framing or panneling.

STRAIGHT ARCHES. Heads of apertures which have a straight intrados in several pieces, with radiating joints, or bricks tapering downwards.

STRAIGHT JOINT FLOOR. See Folded Floor.

STRAINING PIECE. A piece of timber for the purpose of preventing the nearer approach towards each other of two other pieces.

STRETCHERS. Bricks or stones laid lengthwise.

STRETCHING COURSES are those courses in which bricks or stones are laid lengthwise.

STRING COURSE. See Course.

STRUTS. Pieces of timber which support the rafters, and which are supported by the truss posts.

STUCCO, or Finishing. The third coat of three coat plaster, consisting of fine lime and sand: the best sort is twice hand floated and well troweled. Bastard stucco has a little hair, see Finishing. Rough stucco is only floated and brushed in a small degree with water; troweled stucco is accounted the best.

STYLAGALMATIC. That species of architecture in which figures perform the office of a column. See Caryatides.

SUMMER, in architecture. A large stone, the first that is laid over columns and pilasters in beginning to make a cross vault; or it is the stone which being laid over a piedroit or column is hollowed to receive the first haunch of a platband.

SUMMER, in carpentry, is a large piece of timber which being supported on two stout piers or posts, serves as a lintel to a door, window, &c.

SURBASE. The upper base of a room, or rather the cornice of the pedestal of the room, which serves to finish the dado, and to secure the plaster against accidents, which might happen from the backs of chairs, or other furniture at an equal height.

SURBASED. See Dome.

SURMOUNTED. See Dome.

SWELLING. The same as Entasis.

SYSTYLOS. An intercolumniation equal to two diameters.

TÆNIA. The listel above the architrave in the entablature of the Doric order.

TAIL of a Slate or Tile. The bottom or lower end of the slate, &c.

TAILLOIR. The French term for the abacus.

TALON. The same as Ogee.

TELAMONES. Figures of men that support an entablature.

TEMPLETS. Short pieces of timber laid under girders and beams to distribute the weight.

TENON, in carpentry. The end of a piece of wood diminished by one-third of its thickness, to be received into a hole in another piece called a mortise, for jointing or fastening the two together.

TERMINUS. A stone anciently used to mark the boundary of property. A pedestal increasing upwards, or sometimes a parallelopiped for the reception of a bust.

TETRADORON. A species of bricks used by the Greeks.

TETRASTYLOS. A building having four columns in front.

THEATRE. A building for the exhibition of dramatic shows. It was among the ancients semi-circular in form, (see Amphitheatre,) encompassed with porticos, and furnished with numerous seats, which included a place called the Orchestra, in front of which was the floor of the theatre, called the Proscenium.

THIRD COAT, in plastering. The stucco for paint, or setting for paper.

THREE COAT WORK, in plastering. That which consists of pricking up or roughing in, floating and a finishing coat.

THRUST. See Drift.

TIE. A piece of timber placed in any position acting as a string or tie, to keep two masses together which

have a tendency to spread to a more remote distance from each other.

TONDINO. The same as Astragal.

TONGUE. The projecting part on the edge of a board, which is inserted into a groove ploughed on the edge of another.

TOOTHING. Bricks projecting at the end of a wall, in order to bond thereinto a continuation of the wall when carried up.

TORUS. A moulding of semi-circular profile, used in the bases of columns.

TRABEATION. The same as Entablature, which see.

TRANSOM, in building. A piece that is framed across a double window light.

TREAD. The horizontal part of a step.

TRIGLYPH. The ornament of the frieze in the Doric order, consisting of two whole and two half channels, sunk triangularly on the plan.

TRIMMERS, in carpentry. Pieces of timber that are framed at right angles to the joists against the ways for chimneys, and well holes for stairs.

TRIMMING JOISTS, in carpentry. The two joists into which a trimmer is framed.

TROCHILUS. See Scotia.

TROWELED STUCCO, in plasterer's work for paint. The same as roughed in on brick work, and set or pricked up, floated and twice hand floated.

TRUNK. See Shaft. When the word is applied to a pedestal, it signifies the dado, die, or body of the pedestal, answering to the shaft of the column.

TRUSS, in carpentry. A frame constructed of several pieces of timber and divided into two or more triangles by oblique pieces, in order to prevent the possibility of its revolving round any of the angles of the frame. See page 86.

TRUSSED ROOF, in carpentry. One constructed within an exterior triangular frame, so as to support the principal rafters and the tie-beam at certain given points.

TUSCAN. One of the orders of architecture.

TWO COAT WORK, in plastering, is either laid and set, or rendered and set.

TYMPANUM. The space enclosed by the cornice of the inclined sides of a pediment, and the horizontal fillet of the corona.

VALLEY. The internal angle formed by two inclined sides of a roof.

VALLEY RAFTERS. Those which are disposed in the internal angle of a roof to form the valleys.

VASE. A term sometimes used to denote the inverted bell-like form of the ground on which the leaves of the Corinthian capital are placed.

VESTIBULE. An anti-hall, lobby or porch.

VAULT. An arched roof so contrived that the stones or other materials of which it is composed, support and keep each other in their places. Arched ceilings are a species of vaults, and are circular, elliptical, or of other forms. When more than a

semi-circle they are called surmounted, and when less, surbased vaults.

VOLUTE. The scroll which is appended to the capital of the Ionic order. There are volutes also in the Corinthian order, but they are smaller, more numerous, and always diagonally placed. In the Composite the volutes are also diagonally placed, but larger than in the Corinthian order.

VOUSSOIRS. The arch stones in the face or faces of an arch, the middle one is called the key-stone.

UPHERS. Fir poles, chiefly used in scaffolding.

WALL-PLATES. The plates on which the joists and raising plates rest.

WATER-TABLE. A species of ledge left upon stone or brick walls, about eighteen or twenty inches or more from the ground, from which place the thickness of the wall is diminished. In brick walls the edge is two inches and a quarter wide, thereby leaving that ledge or jutty, which is called a water-table.

WASHER. A piece of flat iron with a hole, placed between the nut of a screw and the wood, to prevent the wood being gulled.

WEATHER BOARDING. Feather-edged boards nailed upright with a lap over each other.

WROUGHT. Brought to a fair surface.

XYST or XYSTOS. A term used to express a portico of great length, in which running and wrestling was practised. It was sometimes covered and sometimes open.

ZAX. A tool for cutting slates.
ZOCLE or ZOCCOLO. See Socle.
ZOOPHOROS. The same as frieze.

A

TABLE

OF

FOREIGN MEASURES OF LENGTH.

Antient Roman foot from ·965 *to* ·970 *English feet.*
Roman mile of Pliny, 4840½ *English feet.*

	Eng. feet.
Ancona foot	1·282
Bergamo do.	1·431
Bologna do.	1·244
Brescia do.	1·560
——— braccio	2·092
Chambery foot	1·107
Ferrara do.	1·317
Florence do.	·995
——— braccio	1·905
Genoa palm	·812
——— canna	7·300
Geneva foot	1·919
Leghorn do.	·992
Lucca braccio	1·958
Mantua brasso	1·521
——— braccio	2·092

	Eng. feet.
Milan decimal foot	·855
—— braccio	1·725
Modena foot	2·081
Naples palm	·861
——— canna	6·908
Paris foot	1·066
—— metre	3·281
Parma foot	1·869
Pavia do.	1·540
Piacenza	1·869
Rhinland	1·023 to 1·030
Rome palm	·733
—— foot	·966
—— deto $\frac{1}{16}$	·0604
—— oncia $\frac{1}{12}$	·0805
—— palmo d' architettura	·7325
—— canna d' architettura	7·325
—— braccio	2·561
Siena foot	1·239
Trent do.	1·201
Turin do.	1·676
—— ras	1·958
Venice foot	1·137
Verona do.	1·117
Vicenza do.	1·136

FINIS.

THE BORROWER WILL BE CHARGED THE COST OF OVERDUE NOTIFICATION IF THIS BOOK IS NOT RETURNED TO THE LIBRARY ON OR BEFORE THE LAST DATE STAMPED BELOW.

FEB 5 1979 LU

CANCELLED

WIDENER
BOOK DUE
OCT 25 1988
CANCELLED
OCT 25 1988